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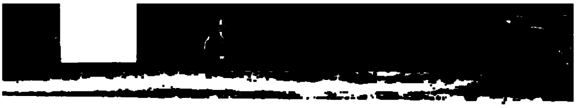

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Sept. 30, 1891.

CLINICAL MANUAL

FOR THE

STUDY OF MEDICAL CASES.

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TO THE FACULTY OF PHYSICIANS AND SURGEONS, GLASGOW, ETC.

SECOND EDITION, REVISED AND ENLARGED.

WITH ONE HUNDRED AND FIFTY-EIGHT ILLUSTRATIONS.

PHILADELPHIA:
LEA BROTHERS & CO.
1886.

NP

PHILADELPHIA:
DORNAN, PRINTER,
N. W. cor Seventh and Arch Streets.

6

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54782

PREFACE TO SECOND EDITION.

CONSIDERABLE delay has occurred in the issue of this edition, as the pressure on his time, from some other work, prevented the Editor from undertaking, at an earlier period, that thorough revision of his Clinical Manual which a new edition of a book of this kind necessarily demands after the lapse of a few years. Every portion has been revised by the original contributors and by the Editor himself: such additions and alterations have been made as seemed desirable. Large sections, here and there, have been entirely re-written, and the number of illustrations increased from 85 to 160. These changes have led to an increase in the size of the book: although in a sense this is to be regretted, it could scarcely be avoided.

The plan of the book remains unchanged. It is designed to afford such assistance as students, actually working at Clinical Medicine, might seem to require. It is hoped that it may continue to be useful to them in their clinical work, even after they have completed their course at the schools.

The manner of using this Manual will depend on the subjects brought up before the student in the course of clinical instruction, and on the way it is employed by those teachers who may recommend it as helping to lighten their labors in the details of clinical teaching. In the absence of any such guidance, the student is recommended to read the first three chapters: from these he will learn the scope of the work, and he will then be able to select for himself, with the aid of the Index, such portions of the Manual for consecutive reading or for special reference and consultation as his requirements from time to time seem to demand. It will be seen at a glance that this book does not aim at supplying any short and easy road to medical diagnosis: its object is to guide the student to a careful examination of the symptoms in his patient, and to supply information as to the methods and results of clinical investigation. To interpret these aright reference must often be made to various systematic treatises: some bibliographical notes are appended to the chapters to aid the student in this important part of his inquiry.

The Editor has to acknowledge much assistance obtained from many friends versed in special departments of medicine: he would be only too glad to enumerate their names were it not that this might imply a greater responsibility than it seems fair to impose on them for their kindly help.

Dr. John Wilson has supplied some additional drawings for this edition: these, along with all the others, are acknowledged in the list of illustrations.

To two of his former hospital assistants—Dr. Malcolm MacMurrich and Dr. Robert Stevenson Thomson—the Editor's thanks are due for their aid in revising the sheets: the Index for this edition has been prepared by Dr. MacMurrich.

J. F.

351 Bath Crescent,
Glasgow, September, 1886.

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CLINICAL MANUAL FOR THE STUDY OF MEDICAL CASES.

CHAPTER I.

THE PHYSIOGNOMY OF DISEASE.

In examining for medical purposes a patient affected with some bodily disease, it is of importance for the inquirer to have before his mind from the first the nature and the scope of the inquiry proposed, and not to be misled by any of the merely conventional phrases or forms of thought under which plausible fallacies and rash generalizations are so prone to hide themselves. This remark applies with peculiar force to the investigation of the more external or physiognomic characters of diseases, because it is in dealing with these that the physician is under the strongest temptations to appear wise at all hazards, and thus to formulate his knowledge (or his ignorance) under terms which may or may not be correct as regards the individual case before him, but of which he would find the exact definition extremely difficult or impossible. Thus, it is very easy in a particular case to pronounce the patient "of a phthisical aspect," or "of a gouty habit," or "strumous," or of a rheumatic or other "diathesis," or to say that he has a well-marked "malignant," or "cancerous cachexy;" and any one of these expressions may, in the particular case, indicate something that is really true, while, nevertheless, the expression itself is altogether objectionable, and devoid both of real accuracy and scientific value. What the clinical observer has to do is not to grasp at a hasty generalization, but to note details of positive fact, and out of these to evolve the elements of a sure diagnosis. The statement that the patient has some peculiar and specific constitutional morbid tendency or bias is not, in any case, the statement of a fact, but of an opinion, and sometimes of a very insecure and fanciful opinion. Such a statement, therefore, should never be found among the preliminaries; probably, indeed, rarely even in the more advanced stages, of a hospital report; inasmuch as even when true in fact, it is an inference based upon many, and much simpler, facts which ought to have been separately noted. The same principle holds, perhaps still more strongly, as regards the so-called "temperaments"—sanguine, bilious, nervous, etc., and all their more complex varieties. Without discussing here at all the amount of truth, or of reality, underlying these expressions, it may be certainly affirmed that their relation to particular diseases is almost wholly illusory; and therefore the statements in which the *elements* of a diagnosis, so to speak, are concerned, should be as simple and precise as possible, and should certainly not involve any general doctrine or theory of the disease and of its causes.[1]

Nevertheless, it is quite true that diseases, considered as disturbances of the physiological course of a healthy life, are often marked by incidents which leave indelible traces not only in the history, but on the physical structure of the body; and it is the study of these, properly speaking, which affords to the well-informed physician almost the whole basis of objective fact out of which a morbid tendency, or diathesis, can be inferred with a fair amount of probability. In other words, *diathesis*, as a study of facts, in an individual case, is an inference either from previous facts in the history indicating deranged physiological function, or from manifest structural changes, the result of these; whereby we are enabled to establish, but only as a presumption founded with more or less probability on the evidence, the existence of a *tendency* to similar changes, or changes of some allied order, in the future. In other words, the proof of *diathesis* is essentially the proof of *disease;* but, it may well be, disease in its earliest manifestations and least notable forms.

There is a whole group of diseases, for example, which affect the human body chiefly or exclusively during its period of growth, whether of early infancy or of adolescence; and another group, the first approaches of which are usually observed only along with, or succeeding, the physiological signs of senile decay. As regards the latter group, it may be said with truth that physiology and pathology are inextricably intermingled. A too early *arcus senilis*, the premature development of "crow's feet" at the outer margins of the eyelids, wrinkles in the skin of the face, diminished sensibility of the retina, or early presbyopia; still more, the well-known changes in the arteries, twisting or rigidity of the radials, etc; falling or grayness of the hair, diminution or loss of sexual activity, and cessation of the catamenia in women; all of these (and yet perhaps none of them singly and unsupported by the others) may be appealed to as evidence of a liability to diseases of the senile group generally; and, if further corroborated by slight manifestations of actual disease, or of organic changes the result of disease, may form considerable elements in the diagnosis of a diathesis, as, for example, a tendency to hemorrhagic apoplexy. Or, again, certain transverse markings upon the teeth (quite distinct in character from those to be afterward noticed as syphilitic); curvatures, or other alterations in the form of the long bones, and a certain well-known conformation of the thorax, may indicate with the utmost precision disorders proper to the period of the first or of the second dentition, when rickety distortion, with or without bronchitis and other severe but not permanent conditions of disease interfering with the free expansion of the lungs, may have left an impress upon the bony skeleton. So, too, it may be remarked that the presence or absence of traces of past disease of the bones and joints, or of glandular enlargements and cicatrices in the neck, or of spinal disease, may, together with a certain conformation of chest, or indeed of the body generally, form part of a chain of circumstantial evidence, as it were, tending to prove, or to disprove, a liability to tubercular disease of the lungs. But what has chiefly to be rooted out of the mind of the ill-informed, or imperfectly trained, clinical student is the impression that such conclusions are to be safely reached through mere phrases appealing largely to the imagination without minute and careful study of details. The popular, and to a certain extent the half-educated, medical mind is always looking for a pathognomonic sign, or a broad, striking, easy, generalization from a few facts; whereas it is only by ripened experience that we come to know gradually the real value of common and obvious, still more, of uncommon and not obvious, *facts when seen in combination*, so as to form conjointly a basis for large inferences. Such a diagnosis, however, is often the result of the careful study of the *physiognomic* characteristics of individual patients.

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[1] The admirable lectures of Mr. Jonathan Hutchinson—"The Pedigree of Disease," London, 1884—published since this paragraph was issued in the first edition of the present work, do not appear to the author essentially to modify anything herein set forth, but rather to confirm the methods of procedure above insisted on. (See especially the remarks on temperament and diathesis at pp. 22, 23, 29.) The position taken by this distinguished investigator may be indicated by two very brief extracts, as follows: "We may perhaps define the term *temperament* as applicable to the sum of the physical peculiarities of an individual, exclusive of all definite tendencies to disease. . . . If there be a distinct proclivity, we must then use a stronger term, and speak of *diathesis*." "Temperament—the original vital endowment of the individual—is unquestionably a real force, and one which we would most gladly recognize and estimate if we could. The scepticism which I have been expressing applies not to the reality of the thing, but to our ability to discriminate it" (p. 30). The whole work, in fact, although perhaps not suitable for beginners, may be commended to advanced students as a commentary on the rules and methods of diagnosis recommended in this chapter.

In beginning the study of this subject, it is impossible to overlook the importance of the *weight* and *size* of the body as a test of its physiological condition. Many diseases, perhaps indeed all diseases attended by fever, and many or most of the organic diseases of the viscera, whether febrile or not, are characteristically marked by a loss of weight, which often bears some sort of relation to the progress of the disease, especially in cases that end fatally. This tendency is the physical expression of a derangement of the entire textural nutrition of the body, one which, as a rule, becomes apparent externally, in the first instance, through the gradual wasting of the stores of fatty material in the subcutaneous layers and in the interstices of the muscles, omenta, orbits, etc.; but which really carries as an ultimate result the wasting of every texture in the body—the bones, the fibrous tissues, and the nervous centres being (according to Chossat) the last to become appreciably altered in weight; the brain, indeed, almost inappreciably, even in an animal starved to death. But in morbid inanition (as opposed to this physiological kind) there is usually not only deficient, but altered, tissue-formation; so much so, that while fat disappears from all the usual situations in which it is normally stored up, fatty or oleo-albuminous molecules are formed in the microscopic elements of the wasting textures generally, and chemical products, also, of decomposition of the nitrogenous tissues are found in excess in the blood, muscles, and glandular viscera. And this may take place (as in diabetes mellitus), when large quantities of actual nutritious matter of various kinds are passing through the organs of assimilation, and are even digested and assimilated, up to a certain point, with preternatural activity. In such cases it has been said, with a certain amount of truth, that the body becomes *autophagous*, or self-devouring; the muscles feed upon the integumentary tissues, the brain and nerves upon the muscles; the new nourishment conveyed into the system, if any, being wasted and rapidly excreted, along with the effete matter of the wasting tissues. This state of morbid emaciation is most easily recognized in the living patient by gradual loss of weight, as well as by the external characters of shrinking and shrivelling of the soft tissues, in the order indicated above as a general rule.

But loss of weight, as a personal and individual fact, can be exactly established only by repeated weighings of the same patient at intervals; and in hospital wards this ought to be done on admission, and afterward every week or two, so as to obtain an accurate view of the progress of the case. In private practice, among men of the well-to-do classes, it is quite common, nowadays, to find that the habitual or physiological weight of the individual, and even the amount of variation in it in the midst of apparent good health, are well enough known to patients themselves, from actual weighings more or less frequently repeated; and by availing ourselves of these spontaneously provided data we are often able to form a tolerably clear conception of the morbid changes present at the time of first seeing the patient. But in other cases no such data exist; and the "personal equation," so to speak, of weight has to be adjusted for the individual from more general statements, or from actual observations founded on averages. But this is by no means easy; for the limits of variation in weight consistent with health, even in the same individual, have yet to be determined; and the extreme limits of difference in a number of individuals of like stature are notoriously so wide, even under strictly physiological conditions, as to render all averages inapplicable to the extremes. A vast series of observations by Dr. Hutchinson has, for many years past, been commonly appealed to as affording the nearest approximation attainable to the common English standard of relative height and weight; while a corresponding American standard has been furnished in the reports of the Surgeon-General at Washington. The Greek ideal of robust manhood in the well-known statue of the (so-called) "Dying Gladiator" has been made the basis of a mathematical calculation, by the late Dr. William Robertson, of Edinburgh, by which the statue, reduced to the proportions of a human figure, has been rendered (as it were) into exact terms of weight corresponding with every successive inch and half-inch of stature over five feet; the normal elements of the human body in fixed proportions being taken as substituted for the marble. But all such calculations are, owing to the reasons stated above, of only a limited value to the clinical observer as furnishing a standard of health. It appears, indeed, from more extended and recent anthropometric researches, that not only do the nationalities and races examined differ in their mean proportions, but that sex and age, social position and occupation, each in its degree, exercises a disturbing influence on the general or standard proportion, which is capable of being expressed in figures; so that among boys (say) of 15, girls of the same age, men of 20, artisans, gentlemen; probably also for all manner of varying occupations, certainly for English, Scotch, and Irishmen under like conditions, and (by inference) for all the many diversified races entering into the composition of these, a different standard of weight would have to be established as corresponding with every degree of stature existing in each of these categories.[1] The almost infinite diversities which are thus shown to be concealed under a general average must necessarily lead to caution in the practical, or clinical, application of any of these formulas, without due consideration of the almost unknown limits of the diversities which in any individual instance may be consistent even with ideal good health; and practical experience teaches that a very considerable latitude is to be allowed in this respect, on either side of the mean. Perhaps the following condensed summary may be adopted as an approximation to the ordinary working rule applicable to most adult men:[2]

A man of	5 feet	should weigh from	8 to 9	stones.
"	5 ft. 3 ins.	"	9 " 10	"
"	5 ft. 6 ins.	"	10 " 11	"
"	5 ft. 9 ins.	"	11 " 12	"
"	6 ft.	"	12 " 14	"

In applying these or any other relative numbers to an individual case it will be well to ascertain, as far as possible, the life-history of the actual patient in respect of height and weight proportion, if not in exact figures, at least in such terms as may be conventionally well enough understood for practical purposes. Supposing, for example, that the patient is a well-grown man, verging toward the "sere and yellow leaf," and in advancing age evidently tending to accumulate fat in the abdominal wall and elsewhere—Was he always "stout" (in the sense of his present condition), or was he, as a youth, "thin," or "slender," or "wiry," or "a light weight?" All of these are expressions well understood by most men as conveying easily appreciable relations of bodily conformation, and the last of them might even lead to more exact statements tending to determine the precise time of life when the *sense* of an increasing burden of flesh became manifest as a subjective fact. In the growing period of the body it is quite common to say of persons of slender habit, that they "shot up very fast"—*i. e.*, that the increase in height did not carry corresponding breadth along with it in boyhood; and this expression, or something like it, is often used by mothers as indicating a fear or misgiving that the phthisical tendency, either as a diathesis, or even as an actual disease, may have existed or been manifested at an early period of life. "Wiry," again, is generally open to a different interpretation; it corresponds in a man, to what in a woman would be called (but not, of course, by herself or her friends) "scraggy" or "raw-boned;" viz., a physical conformation in which bone and muscle predominate, and the whole organization indicates a robust and active rather than a graceful or refined personal presence; but, nevertheless, a bodily organization perfectly sound in essentials and eminently fit, from its very hardness and angularity, to do rough work in the battle of life. "Thin," or "slender," in a man, perhaps conveys the trace of an imputation of physical inferiority; or, on the other hand, these expressions may be perfectly indifferent as regards previous health or disease. The physical opposites of these bodily states, within the limits of health, are usually conveyed by the expressions "lusty," or "stout," or "in good condition," and a little good-humored allusion, half in joke, will often elicit most important facts for the physician; indeed, beginners would do well to study the facetious vocabulary of Prince Hal, as applied to that great impersonation of vigorous and humorous rotundity—Falstaff, in the pages of Shakespeare.[1] In women, and especially in those who have still reason to be careful about appearances, it is necessary to take care not to give offence by a too abrupt or coarsely worded question; but with a little tact there is no real difficulty in getting at the facts in a round-about way, and even without using the sickly French slang of "embonpoint," which is supposed by some to be specially polite language as applied to ladies of a somewhat too large and substantial *physique*. But in all these inquiries and observations it is to be remarked that the experience of years, and the critical appreciation of the human form under a great variety of conditions, normal and abnormal, give to the physician in many cases a power akin to that of the artist, incommunicable by words; an instinct of divination, so to speak, by which the true character and the history of the organism may be read in the external features and physical characteristics; and this, not only as to health and disease, but as to all the leading elements of character.[1]

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[1] One of the Tables (VI.) given in the Appendix to this chapter appears to demonstrate from numerical data, that the food of infants under a year old has a most marked influence on their condition and bodily weight, and possibly even on their stature.

[2] The data in the text are purposely given so as not to imply too close or too absolute an approximation to an ideal standard, but to formulate what may be easily retained in the memory for every-day use. At the end of this chapter will be found a number of more apparently precise calculations (including those of Dr. Hutchinson above mentioned); the differences among these being significant of the latitude that must be allowed in an individual case, as well as some of the more calculable elements in the variations above referred to.

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[1] "King Henry IV.," Part I.—The converse of the character of that lusty knight, who might be supposed to be the original of the proverb, "Laugh and grow fat," will be found in Cæsar's remark on Cassius as a probable conspirator, and "dangerous," on account of his "lean and hungry look," his much thought and reading; his keen penetration "quite through the deeds of men;" and his contempt of personal gratification and amusement. A perfect type of what would be styled in old medical language the "bilious," or rather "atrabilious," or "melancholic temperament."—See "Julius Cæsar," Act I., Scene 2.

There is one remark that will not perhaps quite readily occur to the superficial observer, but which is, nevertheless, of the widest possible application to the subject of body-weight, and of the greatest significance in respect to the physiognomy of disease. It is natural, perhaps inevitable, to think of great and small body-weight as being really opposed or contrasted conditions, just as we think of giants and dwarfs as opposed or contrasted in respect of stature and general bulk. But this is a false, or at least a misleading analogy; for while a son of Anak may be in every way as healthy and as well proportioned as a General Tom Thumb, it is impossible to look upon excessive any more than defective body-weight, *per se*, as a mere question of *big* or *little*. Up to a certain point, indeed, and within the limits of strict physiological health, the increase of bulk may be a mere question of degree; *e. g.*, a man of medium stature may be 140 pounds in weight, or he may be 180, or even, perhaps, 200 pounds; if the *proportion* of all the more important or essential bodily parts is fairly preserved—*e. g.*, of the muscles and ligaments to the bones, of the viscera of the chest and abdomen to the external structure, and of the cavities to the viscera—there will not be necessarily, at least, any appreciable impairment of function, or any disease. But the tendency of extremes in both directions is very apt to be toward impaired function, and, therefore, toward actual or proximate structural disease. And in the case of excessive corpulence, still more than that of excessive emaciation, it may be said that the morbid tendency, once implanted, is apt to be *progressive;* the functions and structures that are oppressed by the abnormal growth of fatty tissue being thereby permanently, though very gradually, altered, so that most of the tissues visibly degenerate, and what seems at first sight to be a *hypertrophy* of the bodily frame becomes, in a most genuine and physiological sense, a true *atrophy* of some of the most important and vital parts of it. Thus, fatty atrophy of the heart, of the secreting cells of the liver and kidney, and of other important organs and parts, is extremely common in cases of excessive corpulence; and the blood itself, there is strong reason to think, undergoes in such cases a kind of relative atrophy, both its amount and its nutritious quality being more or less impaired. Hence the old and probably correct observation derived from the days of large bloodlettings, that *stout* subjects (in the sense of *corpulent)* do not bear loss of blood nearly so well as those of more slender bodily constitution. It is also notorious that such subjects often succumb much more readily to fevers and other exhausting diseases than those of "wiry" frame, or even those who, from defectively slender development, may have appeared to be of a much inferior *physique.* It is not at all clear, therefore, that any amount of external fat beyond a fair average is, physiologically speaking, advantageous to the possessor. And it is just at the period of life when the first traces of senile decay begin, that the embarrassment caused by an excess of rotundity is most apt to tell upon the constitution. Generally speaking, a moderate accumulation of fat up to the age of forty, or even forty-five, is wholesome rather than otherwise; and if associated with a broad chest, well-developed and active muscles, an energetic character, and a healthy respiration and circulation, will tend to long life, even if the digestion should be, as often happens, rather feeble. But increase of fat to a notable degree beyond the middle term of life is always to be regarded with suspicion, as implying a probability of vital and dynamic conditions of nutrition tending to precipitate the process of senile decay. And anything like marked obesity persisting to, or increasing at, the age of sixty is a manifest invasion of the prerogatives of that age which has been characterized as that of the "lean and slippered pantaloon." On the whole, it may reasonably be doubted whether the "spare" constitution of body, if it be free from, or escape, the risks incidental to actual disease in childhood and adolescence, is not in reality more favorable to long life than any considerable amount of fat. There are no statistics on the subject; but the medical observation of mankind in general shows that, as in Pharaoh's dream, it often happens that "the ill-favored and lean-fleshed kine did eat up the well-favored and fat kine." And the spontaneous and instinctive expression of the late Mr. Banting as to his excessive fatty envelope, viewing it, as he did, as a "parasite" destructive both to health and comfort, is not so far removed from truth as are many popular estimates of this condition of body.

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[1] It is, however, here especially, because of the almost infinite complexity of the phenomena which have to be considered, that the greatest scope is found for errors or imaginations arising from the desire to formulate prematurely the mere impressions of an individual, without due regard to the "personal equation:" as in the case of a recent American medical author of some distinction, who boldly denounces the "Madonna di San Sisto" at Dresden as a type of female beauty which Raphael would by no means have committed to canvas had he been familiar with the much more perfect models quite commonly to be found in American cities!

Thus it comes to be to a certain extent recognizably true, in a practical and clinical sense, that *overweight* and *underweight* constitute the physiognomic associations of certain forms of bodily disease rather than others, and therefore are assumed as indicating *tendencies* to particular diseases, or *diatheses;* as when we infer (rightly or wrongly) a phthisical taint from a very spare habit of body, or a tendency to fatty degeneration, or to cardiac disease, or to apoplexy, from the opposite. Speaking generally, however, all such judgments ought to be controlled by numerous other observations of detail (some of which will be discussed further on) before they can be accounted as moderately secure, or indeed as anything better than mere guesses at truth. There are innumerable instances of apoplexy, for example, and of allied diseases of the nervous system, in habits quite the reverse of corpulent or plethoric; and instances could easily be adduced even of such notably emaciating diseases as tubercular consumption, scrofula, and diabetes, in persons apparently, or originally, quite the reverse of emaciated. But still it holds as a general observation that in a group of chronic diseases too numerous to mention here, but including all those attended by hectic fever, emaciation is the rule; while in another group, including most of the cardiac and vascular diseases, and many of the senile degenerations, it is rather, on the whole, the exception; while, as has been already indicated, corpulence, *per se,* may not only become a disease, but may lay the foundation of many others.[1]

The ideal of a sound and perfectly organized bodily structure at the various ages of life has been so beautifully presented to us in the masterpieces of ancient and modern sculpture, that every medical student or physician who desires to keep his eye and mind in training would do well to spend an hour now and then in a gallery of casts or marbles, and to compare the perfect forms coming from the chisel of Phidias or Praxiteles, Thorwaldsen, or Canova, with those habitually seen in the hospital or consulting-room. He will then come to appreciate by his senses what is simply a physiological and, indeed, a physical fact, that there is an ideal relation of size and form as between every separate part of the human body; and that every outward and inward structure contributes an exactly balanced proportion to the whole visible result. The study of this proportion, as affected by disease, and as modified by action and suffering, constitutes the physiognomy of disease.

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[1] See on the question of overweights and underweights considered in relation to insurance of lives—Medical Investigations in Life Insurance; United States Life Insurance Company, 1873.

The ancient doctrine of the temperaments, briefly alluded to in the commencement of this chapter, was an attempt to show forth in language founded on the prevailing humoral pathology the conception, that every detail in the external physical appearance of a man's body stands related to the whole of his hereditary, and in a measure also his acquired, bodily and mental characteristics. As a general principle this needs not to be disputed; and some of the attempts in modern times to pour the new wine of physiology and pathology into these old bottles have been distinguished by great ingenuity, although not in accordance with the methods of investigation which it is the object of this chapter to set forth for the young and unskilled observer. It may be sufficient to refer in general terms to the excellent article, "Temperament," by the late eminent anthropologist, Dr. J. C. Prichard,[1] for a general statement of the subject, and to several other works mentioned at the end of this chapter, as well as that of Mr. Hutchinson, alluded to above (p. 14). What can be attempted here is merely to set forth those facts which a really exact observation absolutely demands to be noted in reference to well-marked varieties of morbid conformation, without giving way to any doubtful hypothesis or individual opinion as to the facts. For many most interesting illustrations of idiosyncrasy and diathesis, and of the relation of diseases to climate, food, etc., as influencing the bodily organization, and sometimes even the visible structure of the body, Mr. Hutchinson's book may be referred to with confidence. No one in the present day has brought such large and varied stores of clinical and pathological experience to bear upon these subjects, in their relation to the higher philosophy of medicine. But in an elementary treatise like the present a simple reference to these valuable researches is all that is either possible or expedient. What

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[1] Cyclopædia of Practical Medicine, by Drs. Forbes, Tweedie, and Conolly, vol. iv. p. 159. London, 1835.

, or phthisical atrophy, the fo
be observed, especially in early adu
"clubbing" of the finger-ends, or of
nails; the red line on the gums, sai
acteristic of tubercular disease; the p
ing and elevation of the skin produc
point over the costal cartilages, and de
any undue, and especially any unilate
clavicles, or deformity elsewhere of
equality, or want of symmetry, in the
any rapid and too easy flushing of the
limited flush of the cheek with pallid
which denotes fever in an exhausted
of these may in particular cases be valua
morbid emaciation.[1] In infants and ch
in adults, it is not uncommon to observe
face, with an enlarged abdomen (almost
often tubercular disease). And in ve
presence of emaciation generally, with
and a large head, the anterior fontanel
protruded instead of depressed, is a c

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[1] These subjects are referred to in detail under the se
IV.), "General Signs of Pyrexia" (Chapter III.), "Gum
dealing with the "Physical Examination of the Chest"
dema is the name first applied by Dr. Lawson Tait (Dub
vol. lii. p. 316) to a phenomenon observed long ago by
Hospital Reports, vol. v. p. 70), as probably characterist
emaciation, and as being found most frequently "in in
the irritation"—*i. e.*, on the side first affected and in th
cording to Dr. Tait, the sign attends especially the *soft*
each stroke of the ends of the fingers" (say the first disc
of little tumors appeared, answering exactly to the numb
the fingers, when they had struck the integuments of the
visible for a few moments, subsided, but could be again
percussion." [My observations, in very numerous instan
original description here given more closely than with th
in Dr. Lawson Tait's paper. In

the gravest import, as tending to reveal disease of the meninges of the brain, even should the symptoms otherwise be obscure or wanting; still more, if these indications are accompanied by peculiarities of expression, or abnormal movements of the eyes (strabismus, nystagmus) or of the pupils; or by the phenomenon described by Trousseau as the "tache cérébrale," and considered by him to denote fever with a cerebral or meningeal lesion.[1]

A condition frequently, but not necessarily, associated with the phthisical or morbidly emaciated habit, is *anæmia;* a term which has been variously defined, but which may be taken as corresponding in general not so much with diminution in the absolute quantity of the blood as with depreciation of its quality: a lower specific gravity of the serum, a more or less considerable fall in the proportion of the blood-corpuscles, and of course of the coloring matter. Physiognomically considered, anæmia is recognized chiefly or exclusively by this last character; and the most marked examples of it are those in which emaciation, though perhaps present more or less, is not extreme. If, indeed, the blood is simply reduced in quantity as a part of the general emaciation, but remains not greatly out of proportion to the other tissues (as in many cases of phthisical emaciation), the characters of anæmia will not be at all strikingly present. The lips will remain well colored, and the mucous membrane may even be morbidly congested in such a condition. But when, along with only a moderate reduction in the amount of the solid soft tissues, and without any circumstance tending to the local determination of blood, there is a great reduction in the *quality* of the latter, the consequences as regards the appearance of the patient are very striking. There is, in the first place, an extremely pallid hue of the whole surface, and especially of the face; lips not quite so pale as the rest of the countenance, but entirely devoid of their natural rosy hue; the conjunctivæ of the eyelids similarly pale; the ocular conjunctivæ bluish, from the shining through of the choroid; and all these characteristics brought out the more remarkably in dark complexions, inasmuch as the tints which depend not on blood but on pigment may be unchanged. Thus the skin may be as nearly as pale as that of a corpse, and yet there may be dark circles (chloasma) round the eyes or on the brow; or the natural diffused pigment of the whole surface may be so exaggerated as to give to certain parts of it almost the appearance of the skin of a negro or mulatto (the so-called "bronzed skin" or "Addison's disease"). But in cases of anæmia, pure and simple, there is usually no special pigmentary change, and the whole external characteristics suggest merely an unduly watery or much impoverished blood. The skin is cool, and the tongue may be clean, though extremely pale; there is often a little puffiness of the eyelids and dropsical swelling of the ankles; it may be (as in Bright's disease) even general dropsy of the entire subcutaneous tissues. The muscles are flabby rather than much reduced in bulk; the expression is that of great languor, but not of suffering or of anxiety; if the texture of the skin is fine and delicate, the blue veins may be seen below the surface, but reduced very much in volume as compared with the normal; and in the veins of the neck there is found the well-known humming of the "anæmic murmur," or "bruit de diable." A special variety of this state of pure anæmia is chlorosis, in which greatly disordered or absolutely arrested menstruation in young girls is attended by all the circumstances above noted, often with a very remarkably green tint of the complexion (as the name implies). In all these cases the blood, tested accurately by instruments devised for the purpose, shows a reduction in the amount of coloring matter, or of corpuscles, equal to one-third, one-half, or even more; and in this way a physiognomic sign, which formerly could only be stated in general terms, can now be reduced to most accurate expression, and made subservient to exact observation as to the progress of disease or the results of treatment. (See Chapter IX.)

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[1] On drawing the back of the nail or the blunt end of a pencil along the skin, we find, in the healthy subject, that a momentary whiteness of the part is followed after a time by a distinct red streak. But in certain states this redness is much more easily produced, and is likewise very much more intense and persistent; it is to this excessive redness that the term *tache cérébrale* is applied, from its being frequently observed in cases of acute meningitis. But it is now quite certain that it may be found equally in cases of enteric fever, and in many other diseased conditions.

When this anæmic condition is recognized, we must never rest satisfied in the investigation of the case till we have done our best to ascertain the probable cause. We inquire for the history of any hemorrhages or any of the less obvious forms of loss of blood described elsewhere (Chapter IX.). A similar deterioration may result from the chronic influence of the malarial fevers, for example, or from the recent occurrence of some acute illness from which the patient's system has not fully recovered. But too often such anæmia is only symptomatic of the serious inroads of tubercular, syphilitic, malignant, or renal disease, and the investigation of the urine is so important in all apparently causeless forms of anæmia that it must never be neglected. Present or past suppuration of a chronic character may likewise be responsible for the deterioration of the blood; the extreme pallor and the wax-like appearance of patients suffering from the lardaceous (waxy or amyloid) degeneration of the viscera usually arise from such prolonged suppurations, but this disorder may also be due to less obvious causes. The examination of the blood frequently guides to the diagnosis of leukæmia and to the investigation of the spleen; or the general enlargement of the lymphatic glands may suggest the presence of Hodgkin's disease as the cause of the persistent anæmia. But after eliminating all these causes of the deterioration, we may still find ourselves in the presence of a simple *progressive pernicious anæmia,* the origin and pathology of which still remain obscure, while the tendency to death is very marked.

The converse of anæmia, in medical language still current, is *plethora;* a condition which has had a great deal to answer for in medical pathology and treatment. But plethora, considered merely as a morbid *excess* of blood, can hardly be said to hold its place among recognized pathological states at the present day; fulness of blood, in other words, can scarcely be considered morbid, unless there is some other pathological change either as regards its quality or its distribution. The condition to which the name plethoric is usually applied is one in which there is stagnation of blood in the smaller veins of the surface, giving to it, especially in the face and nose, the rubicund and "port-winey" appearance suggestive of the days when two bottles of that luscious stimulant were regarded as a moderate allowance for a gentleman at an after-dinner sitting. This peculiarity of countenance, as well as the plethoric and well-fed condition generally, when occurring in persons (especially males) past the middle term of life, particularly if associated with hereditary predisposition or with known habits of self-indulgence, has been regarded as among the notes of the gouty habit or diathesis, and also, along with a short and thick neck, as among the predispositions to apoplexy.

There is a very remarkable condition of the blood and of the containing vessels, in one of its aspects allied to anæmia, in another to plethora—that, namely, which, attended with coldness of the surface and rapid depression of the powers of life, corresponds with the so-called "collapse" or "algide" stage of Asiatic cholera. In so far as this condition can be here dealt with, it may be regarded as one in which a highly concentrated blood encounters resistance in being driven through the capillaries; the great mass of the blood, therefore, tending to accumulate in the venous system, and producing congestion, and even ecchymosis, by rupture of the smaller veins. It has been shown by chemical analysis that the blood in this condition has lost a considerable proportion of its water and albumen, owing to the enormously rapid and copious discharges from the intestinal canal; but the blood-corpuscles remain, for the most part, in the vessels. There is, therefore, a strange combination of shrivelling of most of the textures of the body from loss of fluid, and persistence of blood-color, altered, however, in the direction of lividity by deficient aëration. A person in this state has the skin, especially in the face and extremities, of quite cadaverous coldness, and often has the whole attitude and expression of a corpse; the ends of the fingers are shrivelled, the features thin and pinched, the nose and all the extremities livid in a high degree; the conjunctivæ are bloodshot and ecchymosed; the eyes sunk in the orbits; the tongue and breath cold; the respiration and circulation almost inappreciable; but there is no disappearance of the external fat, nor any true emaciation; the breasts, accordingly, in women, and the abdomen in corpulent men, remain well clothed with integument even after death. A condition more or less allied to this is seen in some cases of very acute peritonitis, tending rapidly to death, as in perforation of the bowels, which, like cholera, may cause death by collapse in a few hours, though, of course, without the excessive evacuations above referred to.

The traditional description of the so-called *facies Hippocratica* is not very far removed in some of its details from the state of acute collapse as above described, and has been so often formulated in one shape or other by compilers, as conveying the elements of a fatal prognosis, that it may be well to transcribe the words from the original source: "a sharp nose, hollow eyes, collapsed temples; the ears cold, contracted, and their lobes turned out; the skin about the forehead rough, distended, and parched; the color of the whole face green, black, livid, or lead-colored." But the reader will do well to consult the other physiognomic details in Sec. 2-4 of the Prognostics of Hippocrates (Dr. Adams's translation, vol. i. p. 236) for numerous vivid and picturesque touches which are now among the commonplaces of medical observation. And the description of the phthisical body by Aretæus is equally deserving of perusal, as a sample of accurate appreciation of detailed facts emanating from remote antiquity. The most important facts of the description referred to are as follows, but the whole chapter in the excellent translation of Dr. Adams well merits perusal:

> "Voice hoarse; neck slightly bent, tender, not flexible, somewhat extended; fingers slender, but joints thick; of the bones alone the figure remains, for the fleshy parts are wasted; the nails of the fingers crooked, their pulps are shrivelled and flat, for, owing to the loss of flesh, they retain neither their tension nor rotundity; and owing to the same cause, the nails are bent, namely, because it is the compact flesh at their points which is intended as a support to them; and the tension thereof is like that of the solids. Nose sharp, slender; cheeks prominent and red; eyes hollow, brilliant, and glittering; swollen, pale, or livid in the countenance; the slender parts of the jaws rest on the teeth, as if smiling; otherwise of a cadaverous aspect. So also in all other respects; slender, without flesh; the muscles of the arms imperceptible; not a vestige of the mammæ, the nipples only to be seen; one may not only count the ribs themselves, but also easily trace them to their terminations; for even the articulations at the vertebræ are quite visible; and their connections with the sternum are also manifest; the intercostal spaces are hollow and rhomboidal, agreeably to the configuration of the bone; hypochondriac region lank and retracted; the abdomen and flanks contiguous to the spine. Joints clearly developed, prominent, devoid of flesh, so also with the tibia, ischium, and humerus; the spine of the vertebræ, formerly hollow, now protrudes, the muscles on either side being wasted; the whole shoulder-blades apparent like the wings of birds. If in these cases disorder of the bowels supervene, they are in a hopeless state. But, if a favorable change takes place, symptoms the opposite of those fatal ones occur."—*Aretæus, Causes and Symptoms of Chronic Diseases*, Book I., Chapter VIII., *On Phthisis.*

In association with the various atrophic and anæmic states above referred to, we have to consider the physiognomic import of another much-abused word, around which, as around the words "diathesis" and "temperament," a great deal of very obscure pathology has been made to revolve. *Cachexia*, in its original and etymological sense (*κακός* and *ἕξις*), means any bad or defective habit of body—*habitus depravatus*—usually the result, not the cause, of disease. The term "habit" here implies, of course, chronicity; and the word cachexia is, accordingly, one consecrated by usage to the definition of states characterized by chronic lesions of nutrition, as opposed to the fevers and acute diseases. In the systematic nosologies—Cullen's for example—the *cachexiæ* form an order including all chronic diseases of nutrition which are not strictly local, and not obviously associated with fever. Hence cancers, dropsies, rickety affections of the bones in childhood, and, above all, the various types of glandular, articular, pulmonary, cutaneous diseases, known either as scrofulous or tubercular, are commonly enumerated among the cachexies; and more modern authors add gout, rheumatism, scurvy, and syphilis to the list. But the use of the thermometer tends very much to break down the distinction between the febrile and the non-febrile diseases—between the *pyrexiæ* and *cachexiæ;* and in some of the latter—*e. g.*, in tubercular diseases and in syphilis—the febrile element, though spread over longer periods of time, and, therefore, less intense as a rule, is quite as really, if not invariably, associated with many of the nutritive changes as in the pyrexiæ commonly so called. It cannot, therefore, be admitted that there is anything in the essential nature of a cachexia to differentiate it pathologically from a fever, or from an acute disease like pneumonia. There is, it is true, the element of *time*, implied in the long duration and very gradual evolution of the disease; but the relation of the local changes to the constitutional disease is, in the cachexia as in the fever, a matter of inference from the study of the whole of the phenomena; and it is impossible to admit, *a priori*, that a specific, and latent, constitutional taint always precedes and determines the local affection. The safe rule of physiognomic diagnosis here is, to make the discovery of a cachexia (as of a diathesis) an inference from individual facts actually observed and verified in the particular case; not a general formula such as is often implied under the terms scrofulous, strumous, syphilitic, gouty, or cancerous cachexia. It may be easily admitted, indeed, that these cachectic states actually exist in connection with the diseases named; but what is not so easily admitted is the proof of the cachexia apart from all positive manifestations of actual disease of the special kind implied in its name.

The following brief indications, however, may be noted as regards particular types of cachexia. In the *scrofulous* or *strumous* variety, as also in a certain proportion of cases of tuberculosis in the adult, there may be found evidences of defective nutrition, or emaciation, extending back to childhood, and modifying the entire form of the skeleton, as well as the integument. A slender form, and a narrow or deformed chest may be accompanied by the cicatrices of glandular abscesses, or of sinuses connected with the bones; a delicate, pale skin, or one marked by traces of eruptions on the scalp or elsewhere; often with retarded puberty, and imperfectly developed organs of sex; flabby muscles, attenuated bones, and relatively large (sometimes ankylosed or actively diseased) joints. The upper part of the abdomen may be increased in bulk, from waxy enlargement of the liver; or the whole abdomen, from disease of the peritoneum or mesenteric glands. The upper lip may be tumid, from often-repeated catarrhs, commencing with coryza, in the earliest years of life; all actual disease of this kind having been long in abeyance. The eyes may have suffered in infancy or early youth from ulcerations and obscurations of the cornea, or from repeated chronic conjunctivitis and "ophthalmia tarsi," leading to thickening and granular conditions of the eyelids, or permanent injury to all or any of these structures, or of the hair-bulbs of the eyelids; the ears may have been affected by discharges, mucous, or mucopurulent, indicating inflammation, either external to the membrana tympani, or in the tympanic cavity, and, in the latter case, possibly involving destruction of the membrana tympani, or of the *ossicula auditus*, or of the labyrinth and *pars petrosa* of the temporal bone; and thus, imperfection of sight and of hearing may tell a tale of complicated changes, conveying, by implication, the note of a scrofulous diathesis. Such patients are commonly more or less anæmic, and are often (sometimes periodically) subject to febricula (hectic).

In the *gouty* habit there is frequently no cachexia, properly speaking, at all appreciable until the middle term of life is reached, or past. There may, on the contrary, be all the indications of strong vitality, robust conformation, and great bodily and mental activity. At a certain period of life, however (prematurely or not), the ordinary signs of *ageing* occur; and along with these (and with the cessation of the catamenia in women) come an increase of obesity, or the plethoric development of the facial veins (described above), eruptions on the skin, varicose veins in the lower extremities, manifestly diminished energy, and sometimes oppression of breathing. Preceding or succeeding these signs may occur the special deformities due to the local deposits of uric acid in the joints of the toes and fingers, or (as Dr. Garrod has remarked) in the lobes of the ears. The peripheral arteries often present at this stage well-marked senile degeneration. There are, however, not a few exceptions to these remarks: and the gouty habit may even concur with, or follow, the scrofulous cachexia, as age advances.

It is doubtful whether any very definite cachexia can be said to accompany *cancerous* disease, apart from the local developments of it in the organs, and their consequences. But in the majority of cases of gastric, hepatic, omental, or uterine cancer, and in not a few mammary and other external cancerous growths, there are either extreme emaciation and anæmia, or persistence of the external fat with flabby integuments, and a peculiar sallow, pale complexion; the expression of the countenance at the same time indicating habitual suffering and great despondency of mind.

Dropsical cachexia is most frequently associated with Bright's disease of the kidney. It is marked by great pallor, a languid expression without suffering, unless from difficulty of breathing; often puffiness of the face and eyelids; absence of fever, and an almost perfectly dry, cool skin, sometimes of fine, semi-transparent texture, at other times locally thickened and even wrinkled or furrowed from the effects of former long-continued dropsical effusions, especially in the lower extremities, scrotum, and loins.

It does not appear at all clear (notwithstanding the well-known description by Dr. Todd of the "rheumatic diathesis"), that either in acute or chronic *rheumatism* there is any definable cachexia or physiognomic peculiarity of bodily conformation, apart from the more obvious history and consequences of the disease.

In *rickets*, there is a precursory or incubative stage of impaired general health or cachexia (according to Sir William Jenner, *Medical Times and Gazette*, 1860, vol. i.), extending usually from the fourth to the twelfth month of the infant's life. More or less emaciation takes place, and the movements indicate languor and peevishness or moroseness, perhaps with hot skin and a degree of low febrile irritation. By and by, it is observed that the natural impulse of healthy children to play about does not exist; the child prefers to lie still, and refuses to be amused; the superficial veins become large, and the jugular veins especially are much dilated; the hair continues thin upon the scalp, and the fontanelle remains widely open. Intercurrent diseases of the chest may occur even at this stage, and may considerably modify the progress of the rickety cachexia; but three truly physiognomic characters are specially noted by Jenner, as appertaining to, and distinctive of, rickets, even in advance of the characteristic deformities of the skeleton, which are often not easily observed until the little patient begins to walk. The *first* is, profuse perspiration of the head and upper part of the body, especially during sleep, with large and full veins of the scalp and sometimes undue pulsation of the carotids. The *second* of these early symptoms is an intolerance of covering at night; the child insisting on kicking the bedclothes off, and lying with naked limbs, so as to be "always catching cold," according to the mother, who tries in vain to keep the infant properly protected. The *third* characteristic symptom is positive suffering when touched, or even when approached, by strangers, obviously from general tenderness, both of the surface and of the muscles and bones; an exaggeration of the state above described as existing at the very earliest stage of this cachexia. "A child in health," says Sir William Jenner, "delights in movements of every kind. It joys to exercise every muscle. Strip a child of a few months old, and see how it throws its limbs in every direction; it will raise its head from the place where it lies, coil itself round, and grasping a foot with both hands thrust it into its mouth as far as possible, as though the great object of its existence at that moment was to turn itself inside out. The child, suffering severely from the general cachexia which precedes and accompanies the progressive stages of the bone-disease in rickets, ceases its gambols; it lies with outstretched limbs as quietly as possible, for voluntary movements produce pain." The consequence of all this suffering, after a short period, is further permanently imprinted on the physiognomy in an aspect not only of languor, but of premature sadness and sedateness, as of age, the effect of which is increased by the inability of the muscles to support the spinal column; this, accordingly, becomes curved forward in the cervical region, and backward in the dorsal. The bones of the cranial (especially the occipital) are soft and thin (craniotabes of Elsässer), yielding in some cases to pressure like cardboard; and the form of the skull is altered, flattened behind or at the vertex, and protuberant in front. There is enlargement of the ends of the long bones; the ribs are "very soft, so that there is great recession of each rib where it joins the costal cartilage at each inspiration." It is easy to see in this description of the signs of a "cachexia" a very real and present disease, the source of all the deformities and permanent alterations in rickets, to which we have already alluded as being themselves, in after-life, physiognomic evidence of disturbed health and function during the period of childhood.

The *Syphilitic* cachexia is so plainly a part of the actual disease, defined and demarcated by the well-known succession of the various stages and external and internal lesions, that it seems unnecessary here to treat of it in detail, as the evidence of its presence is dealt with under special sections in connection with the throat, the skin, the bones, the joints, etc. But in long-standing cases of syphilis its deep influence on the system is often manifested, not merely by an appearance of bad health and general delicacy, but also by a dingy, sallow, and somewhat discolored appearance of the skin of the face; this may impart to such patients something of the physiognomic aspect of malignant disease already referred to.

In all bodily conditions involving *fever*, whether classed among the specific fevers or not, there are certain physiognomic characteristics which ought to be constantly present to the mind of the physician, not only as throwing light on the diagnosis, but often also on the prognosis and treatment. Thus, in the earliest periods there are the somewhat collapsed appearance, the pallor, the shivering, and *cutis anserina* which belong to the cold stage. At a later, but still early, period, the face is flushed, the expression is that either of languor or of pain, according as there is or is not a local disease; very often the attitude indicates restlessness, as when the patient is found overnight or in the early morning with the bedclothes tossed and disordered, and the body more or less exposed. In this stage the skin may be dry or moist, or it may be dry on the exposed parts and moist under the clothes, or *vice versâ.*[1] In certain fevers, as in the rheumatic and pyæmic kinds, moisture of surface and often profuse sweating predominate throughout; in others, as in scarlet fever and most of the eruptive fevers, a dry hot skin is more characteristic of the early stages up to the height of the fever. In phthisis, and in most of the fevers accompanying organic disease, sweats of considerable intensity alternate with hot and dry skin, often repeatedly in the course of twenty-four hours (hectic fever). In fevers which accompany diseases gravely affecting the respiration, as in pneumonia and broncho-pneumonia, the flush on the cheeks has a peculiar duskiness or lividity; this is very notably the case, also, in acute tuberculosis. In some cases of pyæmia, as well as in acute pulmonary affections not pyæmic in origin, a yellowish color of the integument, sometimes amounting to jaundice, may take place without any evidence that the liver is directly involved in the disease; and in acute and febrile diseases of the liver itself (abscess, etc.) the combination of the febrile physiognomy with jaundice is more easily explained. Fevers depending on septic poisoning of the blood are recognized by the peculiar odor, as of putrefaction, which exhales from the body even at an early stage, before the cadaveric odor or the symptoms of approaching death have appeared; such cases may have a traumatic origin, or they may occur spontaneously, as in some instances of enteric fever, of erysipelas, of dysentery, and of septic poisoning from infection. Fevers depending on abscess, or upon profuse suppuration in connection with mucous or serous surfaces, are often very specially characterized by the tendency to intense and repeated shiverings, which can be compared only to the commencing stage of the ague-fit. A like disposition to rigors sometimes follows the passing of a catheter or bougie into the bladder, and this without any appreciable injury done to the mucous membrane. All these phenomena may be fairly included in the range of physiognomic diagnosis; the more precise appreciation of temperature through the thermometer will come under consideration hereafter (see Chapter III.). In all fevers which continue for more than a brief period, the tongue becomes more or less coated with a white or yellow fur; in the hectic of phthisis, however, and in some cases of enteric fever and of mild intermittent, the tongue remains surprisingly clean and natural. As the fever advances the fur increases, the papillæ enlarge and become congested, the dorsum of the tongue becomes dry, usually first in the neighborhood of the *raphé*. At a still more advanced stage the tongue becomes dry all over, brown, and roasted-looking, while incrustations of brown epithelial débris (sordes) gather upon the teeth, alveoli, and lips; this condition is specially characteristic of typhus and similar fevers, typhoid pneumonia, and generally speaking of the more severe continued fevers from the middle of the second week onward; it yields very gradually after the crisis, the fur being thrown off sometimes in patches, sometimes more evenly, and the natural moisture returning (see, also, Chapter XI.). At the stage indicated by the phenomena just described, there has usually been more or less of mental disturbance, and the whole attitude and manner of the patient, as well as his words, indicate a wandering mind and semi-unconsciousness, or even an advance into coma, with great and increasing weakness; the posture being in the more extreme cases absolutely prostrate on the back, with the mouth more or less open, the eyes half closed, and sometimes a film of dried mucus and lachrymal secretion on the conjunctivæ; the pupils being often contracted so as to resemble pinholes, and insensible to light. When associated with profuse sweating, or, even apart from this, with cold extremities (the febrile heat remaining in the central parts of the body), the prognosis is as bad as it can well be in any fever. A very unfavorable sign is a starting or twitching movement of the tendons of the wrist (*subsultus tendinum*), and tremor of the muscles generally; still more unfavorable, if possible, are the movements of the hands described by Hippocrates, and reproduced by countless authorities with more or less conscious imitation for more than 2000 years under the name of *carphologia*, *floccitatio*, etc.: "When in acute fevers, pneumonia, phrenitis (acute delirium), or headache, the hands are waved before the face, hunting through empty space as if gathering bits of straw, picking the nap from the coverlet, or tearing chaff from the wall—all such symptoms are bad and deadly."[1] The peculiar deadliness of such symptoms, it may be remarked, depends upon the fact of their indicating at once two apparently contrasted states of the nervous centres and especially of the basal ganglia and mesencephale, if not also of the medulla oblongata, viz., restlessness, with greatly lowered, if not lost, sensibility to external impressions; unconsciousness, with disturbed excitomotor activity, and almost always with entire absence of real sleep (*coma vigil*); the movements are absolutely automatic, and yet they are continuous, being excited by some purely physical irritation of the motor centres arising apart altogether from consciousness, and acting feebly through the efferent nerves upon those groups of muscles especially which, in the normal condition, exhibit the most highly differentiated and exquisitely combined movements under the influence of the will. To the same order of phenomena belong the constant mutterings (*typhomania* or typhoid[2] delirium); the wordless, and sometimes even voiceless, movements of articulation (*mussitatio*) observed in the later stages of many severe fevers, conveying to the mind of the observer merely the idea of unrest, without the faintest suggestion of meaning, or even of consciousness. (Compare sections on "Delirium" and "Sleeplessness," at the end of Chapter VI.)

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[1] A remarkable contrast to these irregularities of the cutaneous transpiration in fevers is to be found in most cases of diabetes mellitus, in which, with great emaciation and disorder of nutrition and of the urinary excretion, the surface often remains throughout harshly dry and cool, the natural perspiration, even under severe exertion, being suspended. Generally speaking, a dry skin which does not very easily perspire, and maintains an equable temperature, is the sign of a "wiry" frame and of good health. Corpulent persons, on the other hand, perspire easily.

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[1] Prognostics, IV ; Adams's translation, vol. i. p. 238.

[2] It should be particularly remarked, as necessary for the reconciliation of old and new terms, that the word "typhoid" is not used here in the special and limited sense given to it by Louis and the French school of the present century, as a designation of enteric fever, but in that larger and more general meaning which it had from at least the time of Galen, of typhus-like (τυφος ειδος). Typhus and most of its derivatives, including typhomania, are Hippocratic words, used in a figurative sense, from τυφος, smoke, as indicating the *stupor* which attends the graver kinds of fever; and, in the case of typhomania, the combination of stupor with restless delirium—exactly the functional contrast referred to above. The etymological facts are interesting, as showing how, even in the most remote period to which the literature of medicine extends, clinical phenomena which only receive their physiological interpretation from modern science were, nevertheless, sometimes very exactly noted.

The specialties of physiognomic diagnosis bearing on *diseases of the chest* are so interwoven with the subjects to be discussed at length in Chapter IX. of this work ("Dyspnœa," "Orthopnœa," etc.) that a few preliminary remarks here are all that seem to be required in order to preserve the continuity of the present chapter. It is impossible to define with precision, in many cases, what is of cardiac and what is of pulmonary origin, in any particular combination of physiognomic peculiarities; because, in point of fact, cardiac lesions almost always bring pulmonary diseases in their train; and it is also the case that certain pulmonary derangements are quite sure to be followed, after a time, by cardiac diseases both functional and organic, which form their necessary and logical supplement. The intimate association of the functions of respiration and circulation in health is the evident cause of their usual, and even necessary, association in disease. One brief statement will, it is hoped, make this perfectly clear, even to the merest tyro in medical observation. The chemical changes in the blood which constitute the ultimate act of respiration, may be intercepted equally—(1) by a cause mechanically hindering the access of air to the blood; or (2) by one which obstructs the flow of the blood generally through the capillaries of the lungs, and thus prevents the access of the blood in circulation to the oxygen which awaits it in the pulmonary air vesicles. The familiar example of asphyxia, or suffocation, is the typical illustration of the first, and obstruction of the pulmonary artery by a large embolus, or thrombus, of the second mode of detriment to the function of respiration; and in both of these cases we have, among other things, the rapid development of cyanosis, or lividity, as the index of the functional lesion. But it is only in cases in which the change is rapid and complete, from unimpaired to nearly abolished, or very greatly impaired, function that cyanosis can be relied upon as indicating accurately the nature and extent of the detriment. As a matter of fact and of daily observation, very grave destructive diseases of the lungs, and also of the heart, may exist altogether without cyanosis; and cyanosis may exist, as a chronic condition, with far less than could have been expected of respiratory difficulty and apparent effort. Hence it becomes necessary to qualify the first, or, *a priori*, apprehension of the physiological facts above referred to by many details of diagnosis resulting from clinical observation; and, although it is perhaps true that there is in nature (hypothetically at least) a typically cardiac, and a typically pulmonic, physiognomy known to the highly skilled observer in certain forms and aspects of diseases of the heart and lungs respectively, it is impossible to state the details of these in such a way as to cover the whole ground of diagnosis in these two departments. In advanced pulmonary emphysema and asthmatic bronchitis, for instance, there is commonly a cyanotic countenance, the apparent lividity being greater or less according to the greater or less amount of blood permeating, or detained in, the smaller vessels. In severe and acute pneumonia, cyanosis is associated with the febrile flush so characteristic of a disease where the temperature frequently rises in a few hours to 104° F. or 105° F., or even higher in some cases. But in very many chronic pulmonary diseases more destructive and fatal than these, and in many cases also of these diseases themselves, cyanosis is either absent or not notably present; because the absolute reduction in the mass of the blood, and especially of its red corpuscles, permits of such an amount of aëration, even with a damaged lung, as to exempt the patient under ordinary circumstances from this particular manifestation of a disturbed respiration.

In many cardiac diseases, and also in such affections of the respiratory system as are characterized by difficulties of breathing amounting to an agony, the patient remains almost constantly in the semi-erect, or even in the erect posture owing to the difficulty or impossibility of lying down with comfort. To this condition the name of orthopnœa (ὀρθός, erect) is applied; to be distinguished from dyspnœa (δύσ-, difficult; πνέω, I breathe), in respect that the latter is, essentially, a mere subjective *sensation* of breathlessness, whereas the former is a quite special kind of difficulty, marked by a characteristic *attitude*, and therefore coming clearly within the range of physiognomic diagnosis. But even in dyspnœa not thus characterized, there may be differences of detail directly indicated in the physiognomy. Thus, the breathing may be simply accelerated, as in simple uncomplicated pneumonia, and in some cases of pleurisy; or laborious, as in most cases of severe bronchitis and asthma, and almost all of obstructive laryngitis, or of pressure from without upon the air-passages. Or, the breathing may be at once slow, and labored or noisy, as in apoplectic coma; or simply slow, and with diminished extent of movement (shallow), as in the painless extinction of chronic exhausting disease; or slow and sighing, at intervals, as in many states of disordered innervation; or it may present the more developed form of this, or what has been called the "Cheyne-Stokes breathing" (to be discussed in a subsequent chapter), when a succession of gasping and rapid acts of respiration alternates with a period of apparent failure of the impulse to breathe (apnœa), the frequency and the depth of the successive inspirations diminishing till breathing appears to be about to cease altogether.[1] All of these characters of the respiratory movements are thus far typical, that they indicate, not perhaps the particular disease under which the patient is suffering, but the whole bearing of the morbid phenomena, wherever they may take origin, upon the function of respiration; the further examination of which in detail, including the physical diagnosis of heart, lungs, etc., may or may not give the key to what would otherwise be an indeterminate position.

In some cases, perhaps, of grave and complicated disorder of the respiration, but still more characteristically in certain *extreme forms of disease of the heart* (which may or may not be attended by dyspnœa properly so-called), there is a very peculiar restless and often sleepless form of *anguish*, which communicates itself, in an all but indescribable way, to the whole attitude and manner of the patient. This may amount to positive pain, or it may not; the peculiar note of its existence, however, is the evident dread of something immediately impending, a feeling which in the most severe cases prints itself upon the countenance, and is further revealed by the uneasy, agonized shiftings of position, and the utter disability for the repose of quiet, natural sleep. Patients in this condition will pass whole nights in a state of restless agitation (*pervigilium*) without delirium, but with a constant dread of falling asleep; or they will yield to long-continued fatigue, by falling into short, uneasy snatches of sleep, broken by sudden starts and alarmed awakenings, and with an almost expressed sense of the instant danger they ever seem to experience that a very deep sleep might at any time become, or pass into, "the sleep that knows no waking." All this makes up (when watched carefully with a skilled and observant eye) a *physiognomy* which is usually sufficiently distinctive of what may be in general terms described as *cardiac suffering;* and when this is enhanced and rendered definite, or its locality clearly indicated by *pain*, and especially by very severe and paroxysmal pain following a certain course, and bearing a certain relation to bodily exertion, etc. (as will be afterward described in detail), it constitutes the phenomenon, or symptom, or disease, which has been termed "angina pectoris," and is known to be frequently associated with sudden death. But here the physiognomic characters above mentioned may present themselves apart from positive pain; or, again, the latter may be extreme, in the absence of the former. But patients may conceal, or misrepresent, their internal sensations, while the functional distress they suffer is clearly manifested through its outward tokens in the countenance, manner, etc.; the study of the truly physiognomic traits briefly indicated above is, therefore, of great advantage to the physician, in his diagnosis of such cases.

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[1] What has been provisionally termed "uræmic dyspnœa" is a phenomenon far too much involved in questions of rather doubtful pathology to be more than merely alluded to in this place; nevertheless, the ingenious researches of Cuffer, though still unconfirmed, may be mentioned as probably of importance in this connection. "Recherches cliniques et expérimentales sur les altérations du sang dans l'urémie et sur la pathogénie des accidents urémiques." Paris, 1878.

In all *diseases of the nervous system* it is of paramount importance to observe the attitude and bearing of the patient, his manner of answering questions, of putting out his tongue, of speaking, eating, handling familiar objects, walking, etc. There should be no hurry in making these observations; sometimes the abnormal facts can be taken in at a glance, as it were; at other times the disease may elude observation altogether, until brought into full view by some particular abnormal act. This applies in a very special sense to disorders supposed to be of the mind, which have often a very distinct physiognomic expression, while in other cases they require to be sought out through tedious processes of detail, amid many difficulties and possible fallacies, or even as underlying positive deception. In all disorders attended with paralysis, tremor, or convulsion, there will be at some time or other visible phenomena affecting one or other of the modes of ordinary activity above enumerated; or there may be deficient power of evacuating or of retaining the excretions of the bowels and bladder. A slight tremor of the lips, and a hesitating utterance, as if the lips and tongue had no grip (so to speak) over the consonants, will, along with a peculiarity in the gait, an unusual stillness in the muscles of expression, and a slight disparity of the pupils, reveal with almost absolute certainty an early stage of one of the most hopeless of diseases—general paralysis of the insane. A similar but more complete absence of facial expression, without any of the other characters just mentioned (unless it be a flaw in the articulation absolutely limited to the labial consonants), will give the key to a more rare, but far less dangerous disorder—double or bilateral paralysis of the portio dura: while a one-sided action of the face and brow, with a permanently open or half-open eye on the side of the paralysis, and a twist of the mouth toward the opposite side, will show forth the much more common, and equally isolated, paralysis of the portio dura on one side only. An open mouth, dribbling saliva, an awkwardly moving or nearly motionless tongue, with very indistinct articulation, will reveal the labio-glosso-laryngeal paralysis of Trousseau and Duchenne, the bulbar paralysis (so called from the seat of the lesion in the pons Varolii) of other authors. The trailing walk of the hemiplegic patient, in which the weight of the body is supported on one limb, while the other (the paralyzed) limb is either dragged on the ground, or lifted by a movement of circumduction proceeding from the pelvis, and favored by a hitch of the whole body, are signs which can be noted at once, along with the motionless, sometimes rigid, hand and arm of the same side, semi-flexed, and with the fingers bent into the palm. The slow, shuffling, and evidently enfeebled gait of the true paraplegic, arising from sheer deficiency of muscular energy; the controlled and, as it were, leaden movements of spastic paralysis, when the feet are lifted with difficulty, clinging to the floor, and tending in progression to fall foul of each other, but still obviously moved deliberately, and without any loss of coördination; and, contrasted with both of these, the incoördinate, erratic, stumbling, and staggering gait of locomotor ataxy, with its evident loss of balancing power; all of these types are equally characteristic, almost at first sight, and easily distinguishable from the limping of hip-joint or other articular disease, and from the reeling, serpentine, plainly bewildered course of the man tending homeward after a debauch, and ready at any time to lie down in the dirt, to save the trouble of further picking his way. More difficult to distinguish from the latter are some forms of apoplexy or of cerebellar disease, of the diagnosis of which, however, it is impossible to treat in this chapter. The wrist-drop of lead paralysis, the irregular manipulations of writer's cramp and other peripheral nervous disorders of the fingers, must also be omitted here, though essentially of the nature of really physiognomic diagnosis. The peculiar jerkings and general "insanity of the muscles" which characterize chorea must also be dismissed with a reference to special articles and treatises; as also the whole subject of tremor, paralysis agitans, and spinal sclerosis.[1]

Reverting to the disorders which seem to have more relation to the mental functions, it may be affirmed with truth that almost every distinct type of insane aberration has its peculiar physiognomy; from the extravagant and excited gestures, shouts, and destructive violence of the maniac, to the muttering and moaning of the victim of pure melancholia, nursing his secret sorrow alone; or the mindless, speechless, slouching, purely animal characteristics of the extreme demented patient, pushed about almost like a chattel by his keeper, without spontaneity, and only capable of being excited into a temporary sense of apparent enjoyment by the sight of food, or of tobacco, or perhaps, in some instances, by objects of sexual desire. And within these divisions lie almost endless varieties —*e. g.*, the hysterical maniac, incoherent, extravagant in speech, laughing and weeping by turns, erotic and shameless in her behavior at times, and with lucid intervals, it may be, of long duration; the harmless and good-humored, half-demented creature, pleased with every slight attention, easily amused, and always busy with some mechanical or artistic occupation—knitting, or drawing, or writing long snatches of nonsense in verse, or playing the fiddle; the suspicious monomaniac, who follows you with his eye at every turn, grumbles and mutters audibly his suspicions, and would no doubt at times lay violent hands on you if permitted; the egotist, who adopts the manner and style of the Emperor of India, or the Queen of Sheba, or of more sacred characters than these, or, it may be, of the Creator of the Universe! Each of these insanities tends to produce, as it were, a physiognomy for itself; the whole physical habit becomes so moulded upon the prevalent delusion, that it may almost be said that a glance at the patient and his surroundings gives some considerable insight into the special character of his mental unsoundness. Still more curious, because more inexplicable, are the physiognomical individualities that lie within the apparently narrow bounds of idiocy and imbecility. There is the congenital idiot, often dwarfish in body and infantile in expression and habits, sexually undeveloped, with a Λ-shaped palate, and one or more apparently accidental bodily deformities, living the life almost of an infant: the *crétin* of the Alpine valleys, goitrous and otherwise physically deformed; the epileptic idiot; the hydrocephalic idiot; the microcephalic idiot; the paralytic idiot. Of all these, and of other varieties, the physical and physiognomic characters have been admirably described by Dr. Ireland in his well-known work on *Idiocy*. (For further details, see, also, Chapter VIII. on "Insanity," in this manual.)

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[1] These subjects are discussed in special sections of Chapters V., VI., and VIII. Consult the index for the names of the various diseases and symptoms referred to. See in particular the sections on "Speech," "Walking and Balancing," "Twitchings," etc.

As, in the insane and the imbecile, physiognomic diagnosis assumes a special importance from their inability, in many instances, to give a coherent account of themselves, so it may be said that in *infancy and early childhood* the physiognomy of disease constitutes by far the most important aspect of diagnosis considered as a whole, unless in the case of positive physical signs directly bearing on the state of the internal organs. If a healthy infant of from four to six months is carefully studied from the medical and physiological point of view, it will be found, of course, to have increased considerably both in stature and weight since its birth;[1] but in addition to the mere growth and increase of bulk, a skilled eye and touch will easily determine the fact that the muscular structures of the limbs have acquired much greater firmness, plumpness of outline, and with these more apparent spontaneity and definiteness, so to speak, of physiological activity. The cause of this change is partly the constant exercise of the muscles themselves, and partly the rapid development of the nervous centres presiding over the muscular movements. As yet, the movements are mostly automatic; there are few, if any, purpose-like acts of prehension with the hands, for instance, until nearly six months old, although an object conveyed into the grasp is held, just as the nipple is held when placed between the lips. There is, however, a constant activity of the limbs, both upper and lower; and a gradual education of all the voluntary muscles, including those of expression and voice, to the function afterward to be performed under the influence of the intelligent will. The child is obviously a sentient and emotional being, and one of the half-conscious impulses which guide its movements when awake is the positive delight which it experiences in giving to every individual voluntary muscle, down even to the smallest of those which move the toes and fingers, a fair share of daily and hourly exercise. Watch an infant, four, or six, or eight months old, crowing with the mere physical enjoyment of perpetual motion, kicking its arms and legs about as it is removed from its bath, and lies naked in its nurse's arms, and you will be compelled to recognize the force of this healthy, but apparently, as yet, unintelligent instinct. It is the same instinct as, in the more developed system of the kitten at a like or yet earlier age, leads it to chase its own tail, and to do a thousand pranks that seem aimless, but are in fact surely guided toward a definite end in the evolution both of the bodily and the mental faculties, viz., the instinct of *play*.[1] Next to the yet more absolutely necessary, and therefore earlier displayed, instinct of suction, this is the faculty that, more and earlier than any other, rules the life and determines the physiognomy of the infant. We have seen, in the graphic words of Sir William Jenner, how this power of spontaneous and wholesome bodily movement is disturbed in the rickety cachexia. It might be added that in almost every serious disease of early infancy and childhood it is possible, by studying carefully the relation of the spontaneous movements to each other, and to the attitude and expression of the child, its cries, smiles, inarticulate noises, its color, state of general nutrition, behavior in sleep and in waking, to arrive at a reasonable and often perfectly just conclusion as to the general nature and locality of the disease. If there is paralysis in any limb; if the spine or any individual joint is weak or pained; if the breathing is obstructed; if the abdomen is pained and tender, or distended; if the bony skeleton is too yielding, and does not afford the requisite support, or affords it only with pain; in each case there is a typical departure from the normal attitudes and modes of activity, as displayed in the waking moments; or from the happy, quiet, sleeping existence of the healthy infant. Of course, it is absolutely necessary that the survey should be, as far as possible, complete and deliberate; do not, therefore, confine the observation to the face, or be satisfied with feeling the pulse, and looking at a bundle of clothes. Note the color of the cheeks, the heat of the skin all over the body, the presence (especially in sleep) of twitchings, startings, sudden catchings of the breath, or breathing with effort and with imperfect expansion of the chest; observe the descent of the diaphragm, the elevation of the ribs on both sides, the state of the abdominal wall and its contents, the state of the fontanelle, the size of the head as compared with the body, and any abnormal flattening of the vertex or projection of either frontal region; the fulness of the veins of the head and neck, the presence or absence of local or undue perspirations; observe if the eyes are completely closed, as in healthy sleep, or half closed, as in some febrile and cerebral diseases; if the child buries its head in the pillow, or has the hair worn away, as it were, on some parts of the head, or has the neck twisted backward, and stiff; or, at a more advanced age, if he grinds the teeth, or picks the nose habitually; if the nostrils are dilated in inspiration, and if there is any noise in the larynx, or in the chest; if the surface shows any eruptions, the mouth and anus any mucous patches or condylomata, or other evidence of syphilitic disease; if the muscles are flabby, or well nourished; if the abdomen is retracted, or tumid and resistant, or soft, natural, and easily manipulated. All or most of these observations can be made even in a sleeping child without disturbing it too much; but, of course, it will be best to take them in the order most convenient for this end. The pulse and respiration should also be numbered, if possible, during sleep. Other observations, as on the mouth, gums, teeth, tongue, throat, nostrils, ears, as also all detailed physical explorations, should be postponed until all the information that can be procured during sleep and waking from these physiognomic data has been carefully gathered and noted, and until some questions as to previous history have been put.

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[1] See Tables VI. and VII. at the end of this chapter.

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[1] Dr. John Strachan has discussed the physiological and educational aspects of this subject in an admirable little treatise—"What is Play?" Edinburgh, 1877; a work which may be recommended to the perusal of every student and practitioner of medicine.

Most of the inferences to be drawn from the preceding observations will be commented on in other parts of this book. We may here, therefore, fitly close our chapter on the physiognomy of disease.

APPENDIX.

TABLE I.—RELATION OF HEIGHT AND WEIGHT IN HEALTHY MEN, ACCORDING TO VARIOUS AUTHORITIES.

Height.	Hutchinson; Common English Standard.	American Insurance. Standard.	Dr. Robertson; calculated according to Greek Model.	Height.
5 ft. 1 in.	8 st. 8 (120 lbs.)	120 lbs.	....	61 ins.
5 " 2 "	9 " (126 ")	125 "	....	62 "
5 " 3 "	9 " 7 (133 ")	130 "	125 lbs.	63 "
5 " 4 "	9 " 13 (139 ")	135 "	131 "	64 "
5 " 5 "	10 " 2 (142 ")	140 "	137 "	65 "
5 " 6 "	10 " 5 (145 ")	143 "	144 "	66 "
5 " 7 "	10 " 8 (148 ")	145 "	150 "	67 "
5 " 8 "	11 " 1 (155 ")	148 "	157 "	68 "
5 " 9 "	11 " 8 (162 ")	155 "	164 "	69 "
5 " 10 "	12 " 1 (169 ")	160 "	172 "	70 "
5 " 11 "	12 " 6 (174 ")	165 "	179 "	71 "
6 " 0 "	....	170 "	187 "	72 "
6 " 1 "	....	175 "	195 "	73 "
6 " 2 "	....	180 "	203 "	74 "
6 " 3 "	....	185 "	211 "	75 "
6 " 4 "	....	....	219 "	76 "

Hutchinson's figures are found in his celebrated paper on "Respiration," in the *Medico-Chirurgical Transactions*, vol. xxix., London, 1846; and in his article "Thorax," in Todd's *Cyclopædia of Anatomy and Physiology*, London, 1849–52.

The American standard is given in the Medical Investigations of the United States Life Insurance Company.

Dr Wm. Robertson's calculations are referred to in the text; they were made for the Scottish Widow's Fund; his table is somewhat abbreviated here.

TABLE II.—MEAN HEIGHT AND WEIGHT, FROM 10 TO 30 YEARS.

Public school boys, naval and military cadets, medical and university students: most favored classes in England. (7709 observations.)

ABSTRACT FROM ROBERTS'S ANTHROPOMETRY.

Age last birthday.	Mean height, without shoes.	Mean weight, including clothes = 9 lbs.
10 years	53 inches.	67 lbs.
11 "	54.50 "	73 "
12 "	56.50 "	80 "
13 "	58.50 "	88 "
14 "	61.00 "	98 "
15 "	63.50 "	110 "
16 "	66.50 "	126 "
17 "	68.00 "	140 "
18 "	68.50 "	146 "
19 "	68.75 "	148 "
20 "	69.00 "	150 "
21 "	......	152 "
25–30 "	69 00 "	154 "

TABLE III.—MEAN HEIGHT AND WEIGHT OF 10,904 GIRLS IN THE UNITED STATES OF AMERICA.

(Including 3681 American, 3623 Irish, 585 German, and 1397 mixed English, Irish, and American parentage.) Dr. Bowditch.

ABSTRACT FROM ROBERTS'S ANTHROPOMETRY.

Age last birthday.	Height without shoes.	Weight, including clothes.
5 years.	41.0 inches.	40 lbs.
6 "	43.5 "	44 "
7 "	45.5 "	48 "
8 "	47.5 "	52 "
9 "	49.5 "	56 "
10 "	51.5 "	60 "
11 "	53 5 "	66 "
12 "	56.0 "	76 "
13 "	58 0 "	88 "
14 "	60.0 "	96 "
15 "	61 0 "	104 "
16 "	61.5 "	110 "
17 "	62.0 "	112 "
18 "	62.0 "	114 "

TABLE IV.—MEAN HEIGHT AND WEIGHT OF BOYS AND MEN BETWEEN 4 AND 50 YEARS.

English artisan class. (13,931 observations.)

ABSTRACT FROM ROBERTS'S ANTHROPOMETRY.

Age last birthday.	Height without shoes.	Weight, including clothes = 7 and 10 lbs.
4 years	38.50 inches.	44 lbs.
5 "	41.00 "	50 "
6 "	43.00 "	54 "
7 "	45.00 "	57 "
8 "	47.00 "	59 "
9 "	49.00 "	62 "
10 "	50.50 "	66 "
11 "	51.50 "	70 "
12 "	53.50 "	74 "
13 "	55.50 "	78 "
14 "	58.00 "	84 "
15 "	60.50 "	94 "
16 "	63.00 "	106 "
17 "	64.50 "	116 "
18 "	65.50 "	122 "
19 "	66.00 "	128 "
20 "	66.25 "	132 "
21 "	......	......
22 "	66.50 "	136 "
23-30 "	66.50 "	138 "
23–50 "	66.50 "	140 "

TABLE V.— HEIGHT AND WEIGHT OF BOYS BETWEEN 13 AND 20 YEARS.

(3695 boys in telegraph service in England.)

ABSTRACT FROM ROBERTS'S ANTHROPOMETRY.

Average weight in pounds, without coat, hat, and shoes.

Height.	AGE AT LAST BIRTHDAY.							Average in lbs.	Height in inches.
	13	14	15	16	17	18	19		
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		
4 ft. 3 in.	62	...	...	...	...	...	...	62.0	51
4 " 4 "	73	70	...	67	...	...	...	70.0	52
4 " 5 "	72	69	...	...	...	...	...	70.5	53
4 " 6 "	74	74	74	67	...	...	...	72.2	54
4 " 7 "	75	76	77	76	...	76	...	76.0	55
4 " 8 "	78	80	78	87	81	...	...	80.8	56
4 " 9 "	82	83	83	86	...	...	...	83.5	57
4 " 10 "	86	86	87	88	94	...	...	88.2	58
4 " 11 "	87	89	91	93	93	91	...	90.7	59
5 "	90	93	92	96	101	109	...	97 0	60
5 " 1 "	96	98	99	101	106	102	119	103.0	61
5 " 2 "	96	101	104	106	109	111	113	105.7	62
5 " 3 "	103	108	108	110	115	117	117	111.1	63
5 " 4 "	111	112	115	115	116	115	120	115.0	64
5 " 5 "	...	107	117	115	120	127	121	118.0	65
5 " 6 "	...	119	117	122	126	126	130	123.3	66
5 " 7 "	...	123	120	125	132	129	138	128.0	67
5 " 8 "	...	...	131	126	131	142	144	134.8	68
5 " 9 "	...	129	142	132	138	144	140	139.4	69
5 " 10 "	...	...	136	144	147	151	137	143.0	70
5 " 11 "	...	...	...	...	149	129	150	142 6	71

This table shows not only the average weight and average height of boys, but also the variation of weight in boys of the same height, *according to age*. For example, there is a steady progression with age at the height of 5 feet 2 inches, boys of 13 being only 96 lbs., and those of 19 being 113 lbs.—a range of 8 or 9 lbs. above and below the mean of 105.7.

TABLE VI.—WEIGHT AND LENGTH OF INFANTS ACCORDING TO THEIR AGE AND THE CHARACTER OF THEIR NOURISHMENT.

(Russow: from Gerhardt's Handbuch der Kinderkrankheiten.)

CLASS I.—CHILDREN OF AVERAGE AGE AND UPWARD.

Nourishment.	WEIGHT IN GRAMMES.					LENGTH IN CENTIMETRES.		
	15 days.	3 mos.	6 mos.	9 mos.	12 mos.	15 days.	6 mos.	12 mos.
Breast milk	3594	5701	7072	8401	9930	51	67	73
Breast milk, with some cow's milk and starchy food . . .	3525	5310	6317	7916	8480	49	64	69

CLASS II.—CHILDREN UNDER THE AVERAGE WEIGHT.

Nourishment.	15 days.	3 mos.	6 mos.	9 mos.	12 mos.	15 days.	6 mos.	12 mos.
Breast milk	3027	4225	5775	6490	7910	49	59	69
Breast milk, with cow's milk and starchy food	2928	4143	5598	5932	6823	43	55	63
Cow's milk and starchy food exclusively . .	2900	4089	4744	5254	6128			

The original figures are here given as indicating the relative variations very clearly. For those not quite familiar with the metric system the following figures will serve as a guide: 1000 grammes, or 1 kilogramme = 2.2 lbs. avoirdupois (nearly); and 10 lbs. = 4536 grammes; 1 centimetre = 0.3937 inch; 50 centimetres = 19.685 inches.

The artificial feeding here referred to concerned the poorer classes of society. Relatively better results might be obtained from more careful and scientific substitutes.

TABLE VII.—HEIGHT AND WEIGHT OF OLDER CHILDREN ACCORDING TO AGE AND ACCORDING TO NOURISHMENT IN INFANCY. (Russow.)

Nourishment in first year of life.	WEIGHT IN KILOGRAMMES.			LENGTH IN CENTIMETRES.		
	12 mos.	4 years.	8 years.	12 mos.	4 years.	8 years.
Breast milk.	9.93	14.2	20.7	73	93	116
Artificial food	7.43	12.0	18.3	66	87	113

BIBLIOGRAPHY.

For consultation, by those who may wish to follow out the medical literature of this subject, the following authorities may be referred to, with a caution, however, in the case of some of them, sufficiently indicated in the opening paragraphs of this chapter: Galen on the temperaments, especially in his treatise De Temperamentis (περὶ κράσεων); and elsewhere in many places, for which see the general index, Kühn's edition, vol. xx. p. 588. For a more brief résumé, see Paulus Ægineta, translated by Adams, vol. i. pp. 84–87.—Lavater, L'Art de Connaitre les Hommes par la Physionomie, Paris, 1806-7.—Baumgaertner, Physiognomice Pathologica, with Atlas in folio, Stuttgart, 1839.—Sir Charles Bell, Essays on the Anatomy and Philosophy of Expression, London, 1824; sixth edition, 1872.—Laycock, lectures in Medical Times and Gazette, 1862, vol. i.—Corfe, Medical Times and Gazette, 1867, vol. i.—Southey, in his lectures on "Individual Hygiene," deals with the temperaments and subjects allied thereto, Lancet, 1878, vol. i.—Wilks, in a paper on "Nature of Disease," has an interesting section on temperaments, Guy's Hospital Reports for 1869.—Duchenne, Mécanisme de la physionomie humaine, ou analyse électro-physiologique de l'expression des passions—Atlas, 2e édition, Paris, 1876.—Bourneville et Regnard, Iconographie photographique de la Salpêtrière, 3 vols., Paris, 1876–81.—Fothergill, Physiological Factor in Disease, London, 1883, Chap. 2.—Jonathan Hutchinson, The Pedigree of Disease, London, 1884.—Charles Darwin, The Expression of the Emotions in Man and Animals, London, 1872; and The Variation of Plants and Animals under Domestication, 2 vols., London, 1868. Although these works of a consummate naturalist are not specially occupied with disease or its expression, they contain a mass of suggestive thought bearing on the subject.—Mahomed and Galton, in Guy's Hospital Reports for 1881, began an attempt to represent the physiognomy of disease by the ingenious method of "composite photographs;" their paper deals with phthisis, but is chiefly interesting as illustrating the method pursued.—C. Roberts, Manual of Anthropometry, London, 1878, may be referred to for details of growth and weight.—Gerhardt's Handbuch der Kinderkrankheiten (an article by Vierordt), Bd. I., Tübingen, 1881, gives full details of the growth of infants.—Statistics Medical and Anthropological of the Provost Marshal General's Bureau, 2 vols., Washington, 1875.—Quetelet, Anthropométrie, Bruxelles, 1871.

CHAPTER II.

EXAMINATION AND REPORTING OF MEDICAL CASES.

CASE-TAKING.

IN examining cases brought under his notice, a physician is guided by the circumstances in which he finds the patient, and by his knowledge and experience of the condition with which he has to deal, and so, while one case is approached in one way, another is dealt with in quite a different manner. No one method can actually be applied to all cases; indeed, no one method could possibly be the best if used indiscriminately. When a patient is gasping for breath and scarcely able to speak, we must reserve our questions for a few important points. When a patient is delirious, muddled, or obviously unreliable, it is vain to try to procure from him a connected statement of his history and his sensations. If actually insensible, or in a fit, we dare not delay our examination of his condition, so far as this can be ascertained, simply because we might prefer to await the arrival of information as to the previous history or the mode of attack; such delay (even apart from all practical questions of treatment) might deprive us of the only opportunity of ascertaining the nature of the ailment. Nor would a physician explore the family history of a person with scabies in the same way in which he would investigate this part of a phthisical case; his questions directed to the patient with scabies on this matter would probably be limited to a few pointed inquiries to ascertain the infectious character of the eruption, from its presence in other members of the family.

Usually we begin by inquiring, more or less fully, what the patient feels to be wrong; this serves to direct the first part of our physical exploration of the organs, and the mischief detected there often sends us back to inquire into the exact way in which the illness began, into the previous health, and the family history; certain points thus ascertained may demand a renewed examination of the organs, or the exploration of other parts.

In urgent cases we seize upon the severest symptoms, the dyspnœa or pain, for example, and try to get the greatest information attainable at the least cost to the patient, sparing him as much as possible the fatigue of questioning or of physical examination, according as the one or the other causes the greatest annoyance or danger, filling up the gaps as well as possible from the information supplied by the attendants.

When there are obvious features of capital importance, such as jaundice, febrile eruptions, bronzing of the skin, pulsating tumor in the neck, serious hemorrhages, profound anæmia, and the like, we often begin with these facts, and having ascertained their origin, proceed in our inquiries to the other parts of the case and its earlier history.

When the illness is obscure, a more systematic examination of all the organs and functions of the body, and an equally careful inquiry into the personal and family history of the patient may be required to unravel the difficulties.

In reporting cases, likewise, very different methods are pursued by the same physician, according to the varying peculiarities and the different points of interest and importance in each case, and also according to the special object he has in view in making the record, whether for the purpose of treatment, of clinical teaching, or scientific research.

The student in the medical wards, however, is not placed in exactly the same position. The cases assigned to him for reporting are usually selected by those in charge of the patients, and they seldom fail to warn the student when prolonged physical examinations would be dangerous, or when special parts of the investigation must be omitted or passed over slightly. To the student, therefore, a more uniform plan can be recommended, and it is the more useful to him, as without some method to guide him he is apt to omit noticing various important features of the ailment. This may arise from forgetfulness, or from there being so many points which have to be investigated; but the student is likewise apt to omit important parts of the inquiry from supposing that the indications of disease found by him in one part are sufficient to account for the whole illness; having found, for example, the presence of albumen in the urine, and other evidence of renal disease, the beginner may never think of examining the heart, and may pass over a distinct loss of vision without remark, supposing it to be due to a mere accidental coincidence.

It is in the examination of the actual state of the patient (status præsens) that the student chiefly requires the assistance of some method in his investigation of the various symptoms and physical signs. Many clinical teachers have forms drawn up to guide their students in the reporting of cases in their wards. As furnishing a memorandum, to refresh the memory, such forms are useful for beginners, but the slavish following of any such form is to be avoided.

The examination of patients demands a review of the manner in which the various functions of the body are performed. It is usual to divide the manifestations of disorder into two classes—the "subjective" and the "objective." The "subjective" comprises those of which the patient himself is conscious and for a knowledge of which we have to rely on his statements. The "objective" includes those of whose existence the examiner has evidence from his own senses. The subjective manifestations of disease are those spoken of by many writers as "symptoms," the objective being named "signs," or sometimes "physical signs." Some authorities, however, do not draw this distinction between "symptoms" and "signs;" they use the word "symptom" as including both forms of evidence, and so they divide "symptoms," in their diagnosis, into (*a*) "subjective" and (*b*) "objective." It is well to keep clearly in view the distinction implied above, whichever meaning may be attached to the word "symptom," the more restricted meaning of which seems best for ordinary use. This distinction is, as a rule, clear and definite enough. A pain is a "symptom" (subjective); a bulging in the chest, to which it may be due, is a "sign" (objective): giddiness is a "symptom" (subjective); the staggering resulting from it is a "sign" (objective). Frequently, however, we find that no very accurate distinction is possible; coughing is both a subjective and objective manifestation of disease, and so is vomiting; bad forms of aneurismal pulsation may constitute the leading complaint of the patient, and may be perceived equally by him and by the physician. Breathlessness is really a sense of the want of breath on the part of the patient, and so is purely "subjective;" but in its extreme forms at least it is so obvious to any onlooker that it might be classed as "objective." Technically and strictly, the sense of breathlessness and its attendant distress are "subjective;" the rapid breathing, the effort in inspiration, or the posture assumed by the patient during this breathlessness, may be classed as "objective."

A preliminary division which is found convenient is to separate the "external" from the "internal" part of the examination, and it is safer always to begin with the external portion, as otherwise it is apt to be neglected. It can usually be dismissed rapidly, although there are some cases where this constitutes the main part of the examination.

Under the *external* portion may be included those obvious features which go to form the "physiognomy of disease," or refer to peculiarities in the conformation of the patient. The temperature of the body, although really an internal phenomenon, is usually judged of by the feeling of the skin, or by the application of a thermometer to the axilla; it is thus included under this department. The conformation, weight, and muscular development, the apparent age as compared with the real age, the expression and complexion of the face, the presence of dropsy, the posture, and the like, come in here. An examination of the skin for eruptions, discolorations, scars, or tumors of any kind, and a survey of the limbs and joints, for any signs of disease, likewise fall to this portion of the investigation. Such facts as glandular enlargements may be stated in this connection.

The *internal* examination deals with the functions of the various physiological systems, and on the whole the best method is to take up these systems one by one, stating whether they seem to be normal or in what points they deviate from healthy action.

It is usually well, as recommended by the late Professor Sanders, to combine the anatomical with the physiological method, and to deal with the circulatory and respiratory systems in sequence, as they both have their great central organs in the chest: and in the same way to keep in sequence the digestive and the genito-urinary systems as their central organs are in the abdomen.

We begin with the system which seems from the history or from the general aspect of the case to be the one most essentially affected, and we also, of course, consider it in much fuller detail. Hospital cases are usually so far prepared for the student by the previous record of the temperature and the preservation of the urine and expectoration for his inspection.

"If we find orthopnœa, general anasarca, and distended jugular veins, we begin with the circulatory system.

"If we find purulent expectoration, emaciation, and clubbed finger-ends, we begin with the respiratory system.

"If we find albuminous urine and pale puffy countenance, we begin with the urinary system.

"If we find jaundice and protuberant abdomen, we begin with the digestive system.

"If we find paralysis or convulsive twitches, we begin with the nervous system, and so forth." (Sir William Roberts.)

These anatomical and physiological divisions could never, however, preserve us from making serious omissions in our reports, unless each detail in each system were investigated with an absurd and, indeed, a reprehensible completeness. The manifestations of disorder in the various systems often appear in the most unexpected quarters. These points can only be learned by a varied experience of morbid conditions, such as the beginner cannot be expected to possess. The detailed description of the symptoms dealt with in the various chapters of this book are intended to supply, to some extent, from the experience of others, the want thus felt by a beginner, so that when he comes upon any of these symptoms he may know how to pursue the investigation in its various ramifications, and to estimate to some extent the bearing of the facts on the diagnosis.

As an indication of the points to be investigated under each heading, and the order in which the inquiry may be taken up, the following tabular statement is appended. It is slightly modified, for the present purpose, from the form used by Professor Leech, of Owen's College, Manchester:

NAME—SEX—AGE—ADDRESS—OCCUPATION—DATE OF ADMISSION—PHYSICIAN—REPORTER OF CASE.

Preliminary inspection and inquiries tending to elicit general character and duration of symptoms: definite inquiry as to what has brought the patient to seek medical assistance.

PREVIOUS HISTORY:

1. Social.
2. Previous health.
3. Present illness.
4. Family history.

PRESENT STATE:

1. External surface.
2. Nervous system.
3. Special organs.
4. Circulatory system.
5. Respiratory system.
6. Digestive system.
7. Genito-urinary system.

DIAGNOSIS.
PROGNOSIS.

TREATMENT.
PROGRESS OF CASE.

PREVIOUS HISTORY.

1. *Social.*—Particulars concerning residence, coldness, dampness, salubrity—prevalence of special diseases—changes of residence—residence abroad.

Occupation—peculiarities of occupation, as exposure to heat, cold, lead, noxious gases, dust, etc.—changes in occupation—service in army.

Food and clothing—excess or defect, etc.—stimulants, character and amount—tobacco—drugs.

General or special habits and mode of life.

If married, date of marriage—issue—stillborn children—miscarriages and times at which they have occurred.

2. *Previous health.*—Nature and character of previous illness (ailments of infancy in special cases)—previous admissions into hospital—indications of gout, rheumatism, syphilis (gonorrhœa, sore throat, rashes, symptoms of infantile syphilis, if necessary)—cough—hæmoptysis.

Sexual disorders—catamenia—leucorrhœa.

Inquire specially for hemorrhages or discharges, if there be anæmia.

Previous general nutrition and weight.

3. *History of present attack.*—Mode of onset—antecedent occurrences—course of symptoms—treatment before admission.

4. *Family history.*

Father, sisters, } Ages, health; or age at time of death
Mother, brothers, } and the cause of death.

In special cases, grandparents and uncles and aunts.

Diseases in other relatives, especially consumption and scrofulous disease, insanity, rheumatism, and heart disease, gout, cancer or malignant disease: specify whether relative affected was on side of father or mother.

PRESENT STATE.

1. *External surface.*—Posture—temperature—general appearance—form of head—face, color and expression of—worn, languid, sallow, excited, stupid, livid in any part, flushed, anæmic—wrinkles—nostrils—lips—arcus senilis—conjunctivæ—pupils—eyelids—eyeballs—ears.

Relation of appearance to age. Nutrition—well nourished, stout, spare or emaciated, weight, height.

Peculiarities of external configuration, tumors, swellings, deformities, form of joints.

Skin—œdema, face, body, ankles, etc. Perspiration—face, head, body—odor, if any—cutis anserina—roughness—softness—cicatrices—rashes (maculæ, stains, erythema, wheals, papules, vesicles, pustules, scaliness, tubercles), ulcers—discolorations and superficial vessels.

Hair on head, body. Nails—curving—clubbing of fingers—onychia—structural alterations.

Glands—superficial, back of neck, along sterno-mastoid, in axilla, groin, parotid.

2. *Nervous system.*—Intelligence—mental peculiarities—emotional influence—hysteria—coma—delirium—vertigo—headache, its nature and locality—sleep—dreams.

Rigors—lassitude—pains in back—tenderness on pressure along spine—effect of application of hot sponge.

Paralysis of muscles—face, body, and extremities—hemiplegia, paraplegia, monoplegia.

Want of coördination—muscular sense—nutrition of individual muscles—electrical reactions.

Rigidity—tonic or clonic spasms—tremors—choreic movements—character of convulsions or fits—reflexes, superficial and deep—excitability.

Alterations of sensation—anæsthesia in relation to touch, temperature, and weight—analgesia—hyperæsthesia—hyperalgesia. Pricking—formication—coldness—sense of constriction—neuralgic and other pains. Note exact seat of pain—recurrency, constancy, intermittence, and whether altered by movement or rest.

Walking—various methods, staggering, etc. Difficulties and modes of speech, aphasia, etc. Tendons. *Joints*—character of changes in joints—special joints affected—surface temperature—redness—pain—tenderness—stiffness—deposits round joints—deformities—presence of fluid.

3. *Special organs.*—Eye and vision—acuteness of sight, field of vision, diplopia, hemiopia, muscæ and flashes of light, colored spectra, photophobia, color-blindness—peculiarities of conjunctival discoloration or arcus senilis, if present—minute examination of movements of eyeballs—nystagmus—ophthalmoscopic examination.

Ear and hearing—deafness, undue acuteness of hearing—tinnitus. Condition of meatus, discharges from it—membrana tympani—mastoid process.

The nose and smell—appreciation of odors, of irritants—perversion of smell—dryness of nostrils, discharges, fetor—examination of nasal cavities.

Taste—acuteness, bluntness, or abolition of taste as tested with bitters, salines, etc.

4. *Circulatory system.*—Palpitation—cardiac pain, dyspnœa or anguish—pulse, frequency, irregularity, or intermittence, large or small, hard or soft, and compressible—sphygmographic tracing.

Inspection—Cardiac region, general appearance—locality, strength, and area of impulse.

Root of neck—venous fulness and pulsation, arterial pulsation.

General surface. Make special investigations as to any peculiarity noted on external examination, such as lividity—pulsation, enlargement of veins, etc.

Percussion. Map out cardiac dulness—percuss over and outside sternum.

Palpation. Feel for apex beat, thrill at apex and base.

Auscultation—listen with stethoscope, between third cartilages, at apex, over ensiform cartilage, at aortic and pulmonary cartilages, etc. Note character of sounds—accent—strength—reduplication. Murmurs, their rhythm and conduction. Examination of blood.

5. *Respiratory system.*—Number of respirations and their character, easy, labored—dyspnœa, inspiratory, expiratory—orthopnœa—result of exertion. Pain in chest—cough—character of sputa (microscopic examination if necessary)—nasal cavities—voice—examination of larynx—physical examination of chest.

Inspection—form, depressions or bulgings, local or general—condition of spaces—movements, character, and amount—note whether breathing is abdominal or thoracic—condition of extrinsic muscles of respiration.

Percussion — dulness — increased resonance — tubular note — cracked-pot sound, etc.—describe exact locality of altered sounds. Note amount of resistance.

Palpation—fremitus, etc.

Auscultation—changes in character of inspiratory and expiratory sounds or their rhythm. New sounds — rhonchi—friction sounds, etc.—conduction of heart sounds—vocal resonance—bronchophony—ægophony, pectoriloquy—whispering pectoriloquy—splashing sounds—metallic tinkling.

6. *Digestive system.*—Lips—teeth—gums—mouth—tongue, mode of protrusion, moist, dry, tremulous, clean, pale, coated, raw, fissured, tooth-marked—fauces and pharynx—deglutition—thirst—appetite—pain or discomfort after eating—acidity—flatulence—time after food at which they appear—hiccough—amount, frequency, and characteristics of vomiting, nature of vomit (microscopic examination if necessary).

Condition of abdominal walls—results of percussion and palpation—presence of fluid or of solid tumors, or of ascites—nature of fluid, if removed—abdominal pain or tenderness—colic—condition of rectum, piles, hemorrhage—frequency of defecation, difficulties—character of motions, abnormal constituents, worms, blood, pus, etc.

Size of liver as determined by percussion and palpation—measurement at epigastrium and in nipple line—feel of surface, hard, nodulated—tenderness—splenic dulness, enlargement, if any—condition of lumbar regions. Hypogastric region—iliac region—herniæ.

7. *Genito-urinary system.*—Frequency of micturition—difficulty, pain, its character and locality.

Urine—quantity in 24 hours in fluid-ounces; color, reaction, specific gravity, clearness or turbidity, presence and amount of albumen and sugar—amount of chlorides—percentage of urea in 24 hours' urine in special cases.

Deposits—their general appearance. Microscopic examination—ascertain presence or absence of epithelium, pus, blood, casts of the uriniferous tubes—their character, number, and variety—fatty particles, renal cells, amorphous lithates or phosphates, crystals of uric acid, oxalate of lime, triple phosphates, etc.

Male—scrotum—testes—gonorrhœa—stricture—syphilis.

Female—menstruation, when established; natural, excessive in quantity, too frequent, accompanied with much pain—leucorrhœa—ascertain if there be any enlargement of uterus by percussion and palpation externally. An examination per vaginam, with speculum and with uterine sound, may be necessary. Note condition of breasts, and state if pregnancy known to exist.

THE PERSONAL HISTORY.

The history of the illness under observation should, as a rule be taken separately from the record of the general previous health of the patient. We begin by seeking to know what symptom, or combination of symptoms, or what circumstance has brought the patient into the hospital, or made him seek medical advice. The points regarded by the person himself as important are thus obtained, and should always be recorded at the beginning of our reports, even although they may not seem to us the most essential features of the illness. The subsequent course of the case has often much light thrown upon it by this record of these indications, for the patient may feel the importance of certain things which may be overshadowed in our minds by considerations based on our theoretical views.

Taking these leading complaints as our basis, we try to discover the date at which they appeared, the order and sequence of the symptoms, and the relative severity of the different parts of the illness at different times, and particularly the date at which the disease laid the person aside from work and confined him to the house, or to his bed, as the case may be. Having traced the date and origin of the present complaints, we seek to ascertain if they arose in the midst of health, or if they sprang out of some previous illness or general derangement. If it appears that the patient regards the present ailment as definitely originating from some other illness, or if from the known facts of disease this relationship seems probable to ourselves, we begin our history of the present illness with an account of the earlier one out of which it has seemed to spring. But if the present illness cannot be well defined by a date of previous health, or if the history is entangled in a long story of former disease or general delicacy, it usually conduces to simplicity to begin by taking the history of the present aggravation of the condition separately, and then to include the former part of the illness in the account of the previous health of the patient. For example, if we find that dyspnœa, dropsy, etc., constitute the chief complaints of the patient, if these have existed for two or three months, and seem to date from a *second* attack of rheumatic fever, six months ago, we may begin with this *second* attack of rheumatism; we trace the sequence of events from it, and reserve a detailed account of the *first* rheumatic attack, and any former illness, for the other part of the case which deals with the previous history of the patient. But if we find a serious hæmoptysis, or a violent pain in the chest, or severe headache and vomiting to form the obvious and urgent complaint of a patient on admission, we deal first with the origin and course of these, even although it may be certain that the patient has long been the victim of chronic lung disease. Having traced the history of these urgent features of his complaint, we can go back and try to unravel the tangled web of chronic ill health in all its various manifestations.

In the case of children, and especially of young children, we may often save time by ascertaining from the mother the point in the child's age up to which he was regarded as healthy. We may note in passing whether the child was suckled, or how he was fed, when he was weaned, when dentition began, and when he was able to walk. From this period of health we trace all the illnesses onward, up to the present, even although there may not be much connection between them. If, again, the child has been delicate from birth, or troubled with many recurring illnesses from the beginning, it is equally important to procure a connected history of all these, so as to judge of the child's prospects in the present attack of whatever kind this may be.

In procuring the history of an illness from the patients or their friends, we should try to get the facts as known or observed by themselves, rather than mere names or theoretical conceptions, such as "inflammation," "brain fever," and the like. Calling an illness "rheumatism," for example, may tend to mislead us in the history of cases which really depend on spinal meningitis or locomotor ataxy. We must try to learn from the patient or his friends, in such a case, what evidence there was of the so-called rheumatic attack, whether it confined the patient to bed, whether it was associated with distinct swelling of the joints, where the pain was localized, whether there was feverishness, and so forth. The story of any so-called inflammation of the chest or lung must likewise be recorded, with such additional information as can be obtained, and in such cases the duration as well as the symptoms should be stated; this may tend to confirm or to throw doubt on the name given. Sometimes, however, when the name of the disease is given with some precision, and stated on the authority of some medical man, or in connection with some hospital, we may accept the name of the disease, adding in our notes the authority on which we do so.

In following up the sequence of symptoms we also aim at representing in our report the facts of the illness as actually experienced and complained of by the patient, apart from all theoretical views; some patients are very fond of importing these into their narrative. The reality or severity of certain symptoms may often be usefully indicated by stating special facts; for example, in a case of swelling of the belly, that the skirts had to be widened, or that the trowsers could not be buttoned; or in a case of weakness, that the person could not walk across the floor without assistance; or in the case of pain, that the patient could get no sleep, or that he screamed out, or fainted in connection with it. Details like these guide our estimate of the value of the history as derived from the patient. We must, likewise, make use of our own knowledge to check the patient's history, particularly in putting special questions to make sure of the real facts when the account seems improbable or incredible. We may also, after getting the history from the patient, inquire as to whether certain symptoms were not present, as he may have forgotten them, but we must, if possible, avoid putting ideas into our patients' minds; leading questions must be sparingly used, or at least reserved for the end of the interrogation, and in particular to bring out negative points in the case with clearness and precision.

The history of the previous health should be, in part, of a general kind, such as patients can readily supply; the dates and durations of previous illnesses should, as a rule, be specified, as well as the names of the diseases; the general state of the strength, especially as regards the ability to work, and the date of any deterioration in this respect must likewise be noted. But in addition to this general sketch we must often put special questions as to special points, which the patient might otherwise overlook. Thus, in cases of heart disease, we always inquire about rheumatism; the indications of this, especially in childhood, are often so slight that they might easily be missed without some special inquiry. In cases of spinal paralysis, aneurism, and some other affections, we must inquire for any strain or injury, and we note its date and the exact manner in which it happened. We must often, indeed, go back upon the history of our patients, especially as regards this earlier portion of it, after the examination of the case in various ways has guided us so far to the diagnosis. Sometimes, moreover, as described in the section on "Family History" (see p. 68), we must search about in our questions for diseases allied to the one suspected to exist, using popular names likely to be known by the patient or his friends.

The inquiry as to previous venereal diseases is often important, but must be approached with delicacy particularly in the case of women, and especially when dealing with those who are young and apparently respectable. We may often gain some information as to syphilis in an indirect way, by inquiring for a history of sore throat, skin eruptions, nodes, nocturnal pains, and falling out of the hair; or, in the case of those who have had children, whether any of these were born dead, whether there had been any miscarriages, whether the children born alive had eruptions on their buttocks, snuffles, or the like. We can seldom place much reliance on the mere denial of syphilis, and it should be remembered that men frequently refuse to admit having had syphilis, although they confess readily enough to having had gonorrhœa frequently: it is apparently the question of constitutional taint and not of morality which determines such denials: with tact in approaching the subject we can often obtain the history and date of infection. The history of gonorrhœa is important in certain arthritic affections, and particularly in cases of urinary irritation, as when stricture follows it, the bladder and kidneys are often involved. Syphilis has to be considered in the history of a multitude of diseases—skin diseases, nervous affections of various kinds, disease of the liver, amyloid degeneration of the liver and kidneys, aneurism, and other forms of disease of the bloodvessels, laryngeal ulceration, etc.

Social History: Habits.—Certain points not of a purely medical character are usually inquired into, in addition to the bare facts as to age, occupation, residence, marriage, etc., which are taken in all cases for the routine purposes of the hospital records; special points must often be searched out.

The age often suggests a comparison between the alleged and the apparent age of the patient.

The occupation may have to be scrutinized as to the special peculiarities of the employment, and the exposure to evil influences known to beset certain trades; former occupations sometimes explain certain ailments, and this is important in connection with those who have been discharged from the army and are now engaged in other pursuits.

Occupations which are apt to injure the health or to favor the development of disease can only be roughly indicated here. Soldiers and sailors are specially liable to aneurism. Hammermen and others using their arms violently, are frequently the victims of aortic valvular disease, apparently owing to the strain on the great vessels. Publicans and others having to do with the manufacture and sale of alcohol are liable to disease of the liver, kidneys, and nervous system: this arises partly from the injurious influence of the vapors, particularly in badly ventilated places where they may work, but chiefly from the constant exposure to temptations to excess which many cannot resist. Some of those employed as commercial travellers are exposed to similar dangers. Butchers have been supposed to be injuriously influenced by their business, and have been regarded as specially liable to apoplectic attacks. Coal miners are subjected to the influences of cold and damp in their work, which often implies constrained postures, and so they are found to be liable to sciatica and other more distinct forms of rheumatic disease. Agricultural laborers, fishermen, and others much exposed are also liable to chronic rheumatism. The inhalation of dust in various forms often gives rise to disease of the lungs, and this is specially the case when the ventilation is bad. On this account miners suffer from a special form of lung disease from the coal dust and the soot resulting from blasting, etc. Knife-grinders, stonemasons, and potters are all liable to peculiar forms of pulmonary consumption. Some factory workers owe their liability to lung disease partly to dust and partly to confinement in close rooms. Those whose work is among horses and cattle may more readily contract glanders, farcy, and other animal poisons; they are also more exposed to anthrax or malignant pustule; but workers in hides, horsehair, etc., are also affected at times by this formidable disease. The influence of metallic poisons is shown in those who work with mercury in "silverizing" mirrors. Those who make white lead are specially subject to the injurious influence of this metal; but painters, glass-workers, potters, and at times plumbers, dyers, and others brought habitually into contact with lead are frequently affected. It should be borne in mind, however, that lead poisoning is often due to contamination of the water supply and other articles of food and drink quite apart from the occupation of those affected. Sedentary or studious occupations are apt to be specially injurious to adolescents of both sexes, and the effect is often intensified by this change in their occupation coinciding with a change of residence to a large town and living in lodgings for the first time. In such cases the appetite and digestion are apt to fail, and any tendency to lung disease is readily developed. Sedentary occupations in older people favor indigestion, liver disorders, piles, etc. Girls exposed to prolonged standing, as in serving at counters, or to continuous exertion with their feet in working sewing machines, often suffer in their general health and in their pelvic organs. Firemen on board of steamers are apt to have disorders of the kidneys, no doubt from the profuse sweating to which they are exposed. Bright's disease seems liable to occur in those exposed by their occupation to habitual cold and wet. Mental strain, so notable in some forms of commercial activity, is likewise supposed to lead to Bright's disease; of course, the same influence at business, literary work, or school may lead to various disorders and diseases of the brain. On the other hand, the want of due work and occupation for body and mind is apt to favor hysteria, hypochondriasis, and a multitude of nervous disorders.

The residence may raise questions as to the healthiness of the locality, its freedom from certain diseases and its exposure to others; the accommodation in the particular house may also have to be investigated, as regards its cubic space, its water supply, drainage, etc.; former residences, exposure to malarious influences, to tropical climates, etc., have often to be inquired for, and the results must in many cases be recorded even when they are negative.

The kind of food habitually used often supplies very important light as to certain diseases; the use of tea in excess, especially if to the exclusion of milk, vegetables, potatoes, etc., often explains scorbutic, nervous, and dyspeptic disorders. The excessive use of tobacco is suggested in cases of cardiac palpitation or pseudo-angina pectoris, dyspepsia, dimness of vision, quasi-paralytic disorders, and other forms of nervous disturbance. The use of alcoholic stimulants must be inquired into in cases of liver disease, and so-called "bilious attacks," renal affections, dyspeptic complaints, convulsive attacks, particularly when affecting male adults, and in all diseases characterized by delirium, with or without much fever; the history of any previous intemperance often explains the high delirium present in acute illnesses, and has great importance in the prognosis and the treatment. The form of alcohol used, whether wine, beer, or spirits, is sometimes a matter of importance; even the exact variety of spirit used is sometimes a point of interest; the use of undiluted spirits on an empty stomach seems to be very specially injurious; we must likewise ascertain whether a somewhat excessive use of alcohol was of daily occurrence, or whether the excess was only during an occasional outbreak in the course of weeks or months.

The regular use of other stimulants or sedatives, especially opium, chloral, ether, and chloroform, must sometimes be inquired into.

The fact of marriage, its date, and the number of children born alive and dead must also be recorded, particularly in the case of women, and in their case the number and date of miscarriages or abortions should also be noted in some part of the report.

The practice of masturbation is to be inquired for with great caution, as we must avoid suggesting the idea of evil to those whose minds are free from any such notions; but in certain cases of epileptic seizures, in certain forms of cardiac palpitation in boys, and in some cases of nervous prostration and spermatorrhœa the questions must be put with clearness in the interest of the patients, for their warning, quite as much as for the benefit of the diagnosis. Excessive venereal indulgence, whether within the marriage state or not, is often responsible for nervous disorders, spinal paralysis, locomotor ataxy, and other less definite forms of disease. These effects are more common in the male than in the female.

Family History.

The importance of family history in throwing light on the tendency to special diseases is well shown in life insurance studies. This inquiry embraces a note of the age of the parents and of the brothers and sisters of the patient, and of their state of health, if alive; of the ages at which any such relatives may have died, the nature of the illnesses they have had, and the diseases which caused their death. Inquiries as to other relatives are occasionally important, especially when the number of brothers and sisters is small, or the information regarding them obscure; the grandparents, and the uncles and aunts of the patient, on both sides, are the most important in this respect. In going beyond these to half-brothers or sisters, to nephews and nieces, to cousins, or even to the children of the patient, we necessarily introduce complications from marriage; these, however, may sometimes be allowed for in summing up the inquiry.

Now all this information can seldom be obtained with any feeling of accuracy, and in hospital practice the deficiencies are so enormous as to discourage the student, and perhaps to give him an erroneous view of the value of this branch of the inquiry. We should begin by getting the bare facts as to the size of the family, the ages of those living, and the diseases and ages of those who have died. In some cases, where we can interrogate the mothers of children, with suspected syphilis for example, we should also try to obtain the number and dates of the miscarriages and stillbirths, ascertaining whether these occurred before or after the birth of the child under consideration. The further prosecution of the inquiry must turn upon the facts thus elicited, and upon the other facts discovered in the investigation of the illness. Hence we often revert to the family history at the end of the inquiry, to bring out information on special points as to the health or history of the living or the dead. When the causes of death alleged are doubtful or unsatisfactory, we may sometimes judge for ourselves from the facts of the illness supplied by our informants. In particular, we must receive with great reserve the deaths set down to "teething," "change of life," "childbirth," "cold," "inflammation," etc. Many deaths are set down to childbirth or change of life, although really due to phthisis. Consumption often leads to disorders of the menstruation, or its suppression at an early age; and childbirth is frequently followed by a very rapid progress of the same disease which may not, up to this point, have been clearly recognized, or at least admitted. Regard should be had to the age at which such a death occurred, how long the confinement had been survived, how long the weakness had lasted, and whether it was associated with cough, spitting of blood, or other suspicious symptoms. In these doubtful cases, inquiry as to the collateral branches of the family is important—*e. g.*, if a patient's mother is reported to have died from a cause in doubt we may search with advantage into the history of the maternal uncles and aunts. "Inflammation of the lung" and "pleurisy" must be scrutinized in the same way, especially if other deaths occurred from phthisis or pulmonary affections in the same family; if either pleurisy or pneumonia proved fatal after a prolonged illness, we may suspect that these were allied to phthisis, or that some such tendency existed in the constitution of the victim. The name of "bronchitis" also covers many deaths from phthisis: the age of the subject, the duration of the illness, and the occurrence of lividity, dropsy, etc., may sometimes guide us. "Worm fever," "intermittent fever," "the dregs of the measles," and some other terms of this kind are often merely popular names for tubercular disease. Sudden deaths ascribed to apoplexy are to be investigated as to whether the death was almost instantaneous or whether the illness lasted at least some hours; in the former case cardiac or aneurismal disease is more probable than apoplexy; apoplectic attacks in early manhood, with one-sided paralysis, are to be suspected as due to syphilitic, cardiac, or renal disease. In fact, the name of the disease must be regarded, unless substantiated by good evidence, as of only little account; all the knowledge we possess of the nature of diseases and their relative frequency at particular ages, and in particular countries, must be brought to bear on the scrutiny, and some familiarity with the names of diseases in common use among the poor is also of much value in hospital inquiries.

In inquiring into the illnesses which the members of a family may have had, it is desirable to suggest various diseases allied to the one known or suspected to exist in the patient, using for this purpose various names, so as to meet the limited knowledge of our informants, and also to refresh their memories. Thus in regard to scrofulous diseases, we ask for swollen glands or "waxen kernels," or runnings in the neck, disease of the spine and other bones, bad joints, white swellings or "incomes," as they are termed in Scotland, chronic ulceration of the intestines, and chronic peritonitis, disease of the glands of the bowels, water in the head, consumption of the lungs, or decline, or weakness of the chest with spitting of blood, and so on; we may in this way get at the facts when a more general question fails. It is wise also in most cases to avoid disagreeable words, such as scrofula, in the first instance at least, as many people are so annoyed at the suggestion of such affections being supposed to exist in their family that they are shy of giving any detailed information. In inquiring for a family history of cancer we should likewise be chary of mentioning this dreaded name, at least if our patient's disease is only of doubtful malignancy, trying rather to get our informants to volunteer statements on the subject, and searching for the information wanted under the names of growths, tumors in the breast or elsewhere, disease of the liver, stomach, or womb, with wasting, jaundice, dropsy, floodings, etc.

We must further bear in mind, in these inquiries, the variations of allied diseases which appear in different members of the family, and in different generations; by asking for such by name we often refresh the memory of our informants. Heart disease, rheumatism, chorea, psoriasis, and some other cutaneous affections, perhaps also renal concretions, and emphysematous bronchitis, appear to replace each other in different members of the same family. Thus, a patient may be said to have inherited heart disease from his having inherited rheumatism, leading, as it so often does, to an affection of the heart; but another member of the same family may have had heart disease transmitted to him without any overt rheumatism in his own history. The neurotic group includes the various forms of neuralgia, hypochondriasis, hysteria, insanity, epilepsy, and chorea; apoplexy and hemiplegia are included by some (perphaps doubtfully) in this group, their hereditary character seems rather to be associated with vascular disorders. Not unfrequently the patient seems to inherit an unstable nervous system, predisposing to all sorts of nervous disturbance rather than leading to any one form of disease. Certain rare forms of paralysis, as wasting palsy and pseudo-hypertrophic muscular paralysis, tend to occur in various members of the same family. Sometimes a disease occurs in various members of a family without any inheritance being traceable (*e. g.*, so-called "hereditary ataxy" or "Friedreich's disease"). Gout, disease of the liver, contracted kidney, renal calculus or gravel, and angina pectoris form another allied group. These have also some affinity with the disorders connected with arterial degenerations, and so may lead to aneurismal disease or to apoplectic attacks. Certain forms of glycosuria, particularly in those who are somewhat stout and beyond middle life, tend to occur in patients of this class. Syphilis, which has, of course, marked hereditary characters, assumes such a multitude of forms as to preclude enumeration, but the tendency is for such syphilitic diseases to die out in the course of time from early death or sterility. Abortions, stillbirths, early deaths in infancy associated with cutaneous eruptions on the buttocks, snuffles, and wasting, are important in many family histories; nervous deafness, opacities of the cornea, notched teeth, epilepsy and imbecility are occasional manifestations of the same disorder in those children in the family who survive; in adult subjects who have acquired syphilis we must either put the question of infection directly or investigate their symptoms and condition when the question of syphilis is important in the family history we are studying. The group of scrofulous and tubercular diseases has been already referred to. Diabetes has often a distinct hereditary origin, and at times it is also mixed up with a family history of tubercular tendencies.

Although family history is chiefly useful in determining the tendency to certain chronic and constitutional affections, or to premature decay of the individual, or of certain of his organs, we find, likewise, a tendency in some families to acute diseases—enteric fever, for example, and even to certain degrees of severity or to special complications—as intestinal hemorrhage—and this may guide us at times, especially in prognosis. In diphtheria also we have an illustration of an acute infectious disease affecting special families in various branches and at various times and places to a striking extent. Such cases are very instructive, in view of the recent doctrine of phthisis being due to a specific organism—so far resembling the organisms of the infectious fevers—and in view of the admittedly hereditary character of this complaint.

It is sometimes quite evident from which of the parents a patient has acquired his morbid tendency, and in some insurance reports information is sought as to whether the proposer resembles the male or the female side of the house in his general conformation, so as to judge of his predisposition to diseases which may exist on the one side and not on the other. No doubt there is some guidance to be obtained here when the whole facts are well known to the physician himself, but otherwise he cannot place much reliance on mere statements. Sometimes two perfectly distinct forms of disease are found in the same family, the father contributing one tendency and the mother the other.

TRANSMISSION OF TWO FORMS OF DISEASE.

Family history of a young lady, æt. twenty-five years, affected with a second attack of acute rheumatism, complicated with pericarditis and aortic valvular disease; distortion of the joints supervened.

FATHER.	MOTHER.
Has had rheumatic fever; his brother has "rheumatic gout."	Healthy; but two of her sisters and one of her brothers died of consumption.

FAMILY.

Eldest brother; two attacks of rheumatic fever, with pericarditis both times; died of affection of heart and lungs. Another brother; slight rheumatism in knees, but no heart affection. Eldest sister; pains in knees and shoulders, but no serious illness.

Other five brothers and sisters; none of them rheumatic, but some of them affected or threatened, more or less distinctly, with consumption.

The healthy condition of one parent may indeed tend to neutralize the morbid proclivities acquired from the other; and, on the other hand, *similar* morbid tendencies in the families of both parents seem to tell with special severity on their offspring. It is probably in this way that the injurious influences of consanguineous marriages come out. In remote islands with but few families, for example, repeated intermarriages seem to favor imbecility in the children; and deafmutism has at times, likewise, appeared to be due to similar causes. In other cases, however, two or more deaf-mutes may be born into a family without any such cause or without any hereditary history being known.

The question as to which parent is the more potent in transmitting morbid tendencies cannot as yet be answered satisfactorily. In the case of consumption it would seem, from insurance statistics, that a consumptive mother is more likely to transmit this disease than a consumptive father; and when we have the history of a consumptive mother and of one brother or sister being affected, this fact is usually regarded as adding greatly to the risk. Probably in other diseases the transmission by the mother is more potent also, and in the case of the "hemorrhagic diathesis" the disease is almost invariably transmitted through the female line: this is all the more curious inasmuch as the mothers, and indeed all their sex, almost invariably escape. This disease affords an illustration of hereditary transmission without either of the parents being affected; but one or other of the maternal uncles may be "bleeders," as they are called—even, however, when they marry and have children their children are not affected.

TRANSMISSION TO MALES IN FEMALE LINE.

Family history, showing the occurrence of the hemorrhagic diathesis in three successive generations. Transmission in the female line of descent, but only males affected.

1st Generation.

A *maternal* granduncle (the brother of maternal grandmother) was a bleeder; he died æt. 30; was married, but had no family.

2d Generation.

A *maternal* uncle was a bleeder; he died æt. 26; he had one male child, but he was not affected.

This man had numerous cousins, and two out of his three *maternal aunts* had bleeders in their families—three in all. No bleeders in the families of his five maternal uncles.

3d Generation.

The patient, a boy, æt. 8, and his brother, who died æt. 5, were both bleeders. Other two brothers and three sisters not affected.

Two male cousins bleeders, the children of a *maternal aunt;* one female child in the same family not affected. In another large family of cousins, males and females, by another maternal aunt, none affected.

More misleading still are the facts of atavism; in this case the whole of the generation of which the parents are members escape, but inquiry into the history of the grandparents or the granduncles or aunts of the patient may reveal a strong family predisposition to special diseases.

ATAVISM—TRANSMISSION OF PHTHISICAL DISEASE.

Family history, showing a marked tendency to consumption, derived apparently from the grandparents, without involving the intermediate generation.

1st Generation.

Paternal grandfather, died of "decline in bowels," æt. 62.
Paternal granduncle, died of consumption, æt. 30.
Paternal granduncle, died of consumption, æt. 50.
Paternal grandmother, died of "liver complaint and decline."

2d Generation.

Father, always healthy, killed by accident, æt. 62.
Paternal uncle, healthy, killed by accident, æt. 18.
Paternal uncle, living and well, æt. 66.
Paternal aunt, died, three weeks ill, "sore leg," æt. 50.
Mother, no consumption traceable in her family, living and very healthy, æt. 72.

3d Generation.

Patient and four of his sisters all died of pulmonary phthisis, ages from 23 to 45 years. A brother died of a "rack or strain," followed by purging and vomiting, æt. 23.
Six other brothers and sisters living and well, ages from 27 to 52 years. Of these several have families; one cousin died of consumption, æt. 20, in one family; in another, two cousins died of "water in the head," and one died of "overgrowth with swelling of the belly."

A point in the family history to which special importance is attached by some authorities concerns the time of appearance of the disease in the parents as compared with the time of the birth of the child. In the case of syphilis it is obvious that if the child were born before the parent contracted the disease there could be no transmission. It seems that even in the case of gout, and some other hereditary constitutional diseases, the children born after the pronounced appearance of the disease in the parent are more prone to the affection than those born before that period.

Even after allowing for all these sources of difficulty in interpreting the family history, we must remember that the members of the family who might have been affected, if they had lived, may have been cut off by accident, or by what we might call accidental diseases, such as fevers and some other acute diseases; or we may encounter the difficulty of the diseases in question usually appearing at ages beyond those available in the study of our patient's history. A large family, with all the living members grown up to middle or advanced life, should show pretty clearly the tendency of their family constitution, but even then cancer, for example, is so notoriously disposed to appear at the later periods of life that it may still be absent from the family history at the time we are in search of it. A child may die of cancer supposed to be quite unknown in the family till perhaps his parent dies of the same disease many years later. This defect might be supposed likely to be supplemented by the history of the uncles and aunts, or of the grandparents or the granduncles and aunts of our patient; but there is first of all the enormous difficulty of getting information so extensive and so precise, and even then, unless the numbers be large in such families, we may readily miss the evidence of a family taint. In tubercular disease, likewise, especially in children, the family tendency may not have had time to manifest itself in the other members at the date of our inquiry. The number and ages of those living come in here to enable us to guess, as it were, at the probabilities of such a tendency having had time and opportunity to manifest itself, if really present. A deceptive appearance of soundness in the family history may sometimes arise from there being no account of deaths or illnesses connected with the suspected disease, when really from smallness in the number of the family, or from deaths due to fevers and other accidental diseases, no opportunity was allowed for the morbid tendency to show itself. Such a family history, although not "bad," is not "good;" it is defective in its evidence. In a larger family, again, a stray death may have occurred from phthisis or rheumatism, due, perhaps to exceptional exposure or unfortunate modes of life, although no great tendency to such disease existed in the family. We must, therefore, consider all these points in trying to form a sound judgment.

CHAPTER III.

TEMPERATURE—PULSE—GENERAL SIGNS OF PYREXIA.

TEMPERATURE.

AN increased heat of the body is one of the oldest and most widely recognized signs of fever. It may be estimated roughly by applying the hand, or perhaps the back of the hand, to the surface of the patient's body, selecting some of the sheltered parts, such as the axilla, the groin, and especially the abdomen. It must be borne in mind that a certain coldness of the extremities and of the exposed parts often coexists with a great elevation of the temperature in the interior of the body, and even in the axilla or groin. The variable temperature of the observer's hand, moreover, must be remembered as a fruitful source of fallacy, so that when we aim at accuracy in determining the degree of pyrexia, as febrile heat is often called, or at certainty in pronouncing its absence, we must have recourse to the thermometer.

Clinical thermometers should be sensitive, and should have the bulb of such a size and shape as to be adapted for introduction into various parts of the body. The graduation should be on the stem itself. Accuracy in the instrument is, of course, desirable in all cases, and is especially important if any startling deviation from the usual range of temperature happens to be discovered. Certificates of accuracy, or of the amount of error in the scale, may be obtained by sending the instruments to be tested at Kew Observatory. It is important to have the observations made, if possible, with the same instrument, in the case of a given patient; in this way, although there may be some slight error in the instrument, the changes in the patient's temperature, noted from time to time, are really but little affected by such errors; the *variations* in a patient's temperature, from time to time, are usually more important in the case than the absolute height of the reading within half a degree on either side. If the self-registering maximum thermometer be used, care must be taken to shake down the index below the probable temperature of the patient, before it is applied; if an instrument without any registering index be used, care must be taken to read it *in situ*, as, of course, the mercury falls whenever the instrument is removed from the body. In applying the thermometer to the *axilla*, the following points must be attended to: if there be much sweat, the skin should first be wiped dry; the bulb should be introduced deeply into the axilla, under its anterior or pectoral fold, with the point directed slightly upward, and the arm must be kept close against the thorax; it is sometimes a good plan to make the patient keep the arm in position by means of his other hand, or by lying slightly on the arm during the observation; strong muscular effort on the part of the patient in holding his arm by the side is apt to cause a hollow in the axilla, and so to remove the soft parts from the bulb of the thermometer. We may, indeed, require some one to hold the instrument in position if the patient has not strength or intelligence enough to keep the arm closely applied; care must be taken that no folds of the underclothing interpose between the bulb and the skin; it should also be seen that the instrument does not slip down or project behind and beyond the axilla. *The thermometer must be left in position till the mercury maintains the same level for two or three minutes.* The time required for an accurate measurement of the temperature in the axilla depends on this cavity requiring to be kept closed long enough for it to reach its maximum heat, as this may have been reduced by exposure to the air; it is clear, therefore, that a very different length of time may be required in different observations; the only accurate method is to see that the maximum is really attained, as judged by the stationary position of the mercury; a stationary position for two or three minutes is found to be sufficiently accurate for ordinary clinical purposes. The routine method of keeping a thermometer in the axilla for five minutes only, and then entering the reading, cannot be too strongly condemned as often extremely fallacious; and yet this method of observation is sometimes resorted to in order to prove the efficacy of antipyretic treatment by iced compresses applied to the chest! When self-registering instruments are to be used by unskilled persons, who cannot be trusted to read the index, fifteen minutes may be named as a proper time for the application of the instrument. If the arm be kept closely applied to the side for fifteen or twenty minutes, *immediately before* the thermometer is introduced into the axilla, the necessary time for the actual observation may be shortened. Heating the bulb of the instrument beforehand, to a temperature near the blood-heat, is desirable if the weather be cold or the bulb be large, but it does not materially lessen the time required for the observation, as this depends on the state of the axilla much more than on the coldness of the instrument.

If the *mouth* be used for testing the temperature, the bulb should be placed under the tongue and the lips kept shut, the breathing being performed through the nostrils. The mouth resembles the axilla in being sometimes open to the air and sometimes shut, and similar remarks apply to it as to the axilla. The mouth may often be used with advantage for testing rapidly the temperature, in an approximate manner, in dispensary or private practice, as the clothes do not require to be removed for the purpose. Care must be taken that nothing very cold (as ice) has recently been in the mouth when the temperature is being tried in this place; very hot liquids recently taken are also apt to affect the readings here.

The *rectum* gives results more accurately and rapidly than either of the preceding, and it is sometimes preferable, especially in the case of children, where axiliary measurements are often irksome, tedious, and unsatisfactory. The bulb is oiled, and introduced two inches within the bowel, and held steadily till the maximum is reached; this always occurs in two, three, or four minutes, because we have not to contend here against the cooling influence of the air, as in the case of the axilla and mouth. If very young, the child may be placed with advantage on his left side, in the nurse's lap, with his face to her right breast. The objections to the rectum (apart from the annoyance and exposure involved) are the possible compression of the bulb by the muscles of the bowel which may force the mercury mechanically up the stem of the instrument; the chance of the bulb being inserted into hard feces and so prevented from being in contact with the bowel; and the possibility of its being affected by the descent of fluid feces from a higher and warmer level: in any of these cases the temperature of the rectum itself, which is what we desire, may really be missed. The temperature of the rectum as compared with the axilla may be quoted roughly at three-quarters of a degree Fahr., or nearly one-half degree Centigrade higher than that of the axilla.

The *vagina* yields accurate and rapid results with the thermometer, but is only seldom to be recommended for clinical observations; the temperature in cases of labor, uterine diseases, etc., may sometimes be thus tested with advantage.

The *urine* sometimes affords rapid and useful information, if it be passed directly on to the bulb of the instrument; or it may be passed into a vessel slightly heated, and the temperature immediately taken with a sensitive registering thermometer.

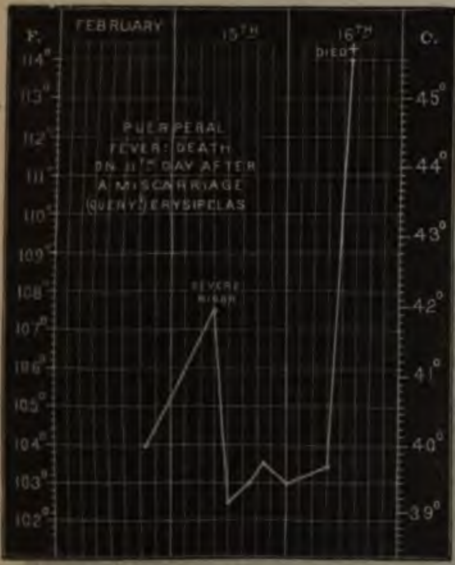
The time of the day at which the temperature is taken should be noted, or at least clearly understood. The human temperature has a daily range, during health, of nearly two or three degrees of Fahrenheit's scale (say a degree or a degree and a half Centigrade), taking the extremes in both directions reached during the 24 hours, and putting the mean at 98.6° F. or 37° C.: the range is more ample in children than in older persons; the temperature rises in the early morning hours, attains a maximum in the afternoon, and falls so as to be at its minimum an hour or two after midnight. In fevers, likewise, there is a daily range, although the temperature is persistently above the normal: the minimum occurs usually some time about 4 A.M.; the daily ascent varies somewhat, beginning usually earlier in the day in severe than in mild cases, but as a rule it is distinctly manifest about mid-day or toward the afternoon: the maximum may be expected most frequently about 8 P.M., or sometimes an hour or two earlier. In hectic fever, and toward the convalescence in enteric fever, the morning temperature is often nearly normal, although the afternoon and evening readings may be very high. (See Figs. 3, 4, and 5.) Sometimes, however, the type is "inverted," the temperature being low at the hours at which in ordinary cases it is high, so that it is high in the morning and low in the evening. The importance of having the observations made at the same hours, so as to have them fairly comparable with each other, becomes thus very apparent, as otherwise we might mistake the diurnal variation for a real aggravation or diminution of the fever. This likewise shows the danger of relying on one observation (especially in the morning or forenoon) as proving the absence of pyrexia. Frequently repeated observations in the course of the day reveal some curious and important facts in the history of the temperature. This sometimes dips down to the normal, or even below the normal, for a few hours in the midst of a raging fever, or shortly before the crises is reached: or equally short exacerbations may be detected. In hospital practice only three, or four, or six observations in the day are usually taken, even in febrile cases, so as to avoid fatiguing or annoying the patients; and in private practice, unless there are skilled nurses or intelligent friends to be entrusted with the observations, only one or two records can usually be obtained: the best hours in such cases are about 9 or 10 A.M., and 7 or 8 P.M. If frequent observations are to be made, the best hours are about 3, 6, and 9 A.M., 12 noon, 3, 6, 9, and 12 P.M.; and special readings should also be made in connection with rigors, convulsions, or other unusual occurrences and also in testing the effect of remedies, or of any special antipyretic treatment.

Normal and abnormal temperatures may be classified as follows:

Below	35° Cent.	=	95° Fahr.	Very low or collapse temperatures.
	36 "	=	96.8 "	
About	36½ "	=	97.7 "	Subnormal temperatures.
Normal	**37** "	=	**98.6** "	**Normal temperature.**
About	37½ "	=	99.5 "	Slightly above normal, or sub-febrile temperatures.
	38 "	=	100.4 "	
	38½ "	=	101.3 "	
About	39 "	=	102.2 "	Moderately febrile temperatures.
	39½ "	=	103.1 "	
About	40 "	=	104 "	Highly febrile temperatures.
	40½ "	=	104.9 "	
Above	41 "	=	105.8 "	Hyper-pyretic temperatures

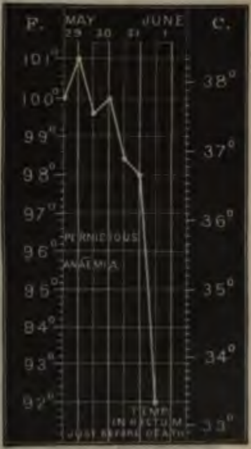
Such a table enables us, on reading the thermometer, to affirm the absence, the presence, or approximately the degree of pyrexia in a patient at a given time; but this really supplies but little information. The temperature may be normal and yet the patient may be dying, or may even be in the midst of a dangerous fever, which will manifest itself in the course of an hour or two as a burning heat. We often, however, detect by the thermometer the presence of pyrexia when we have but little expectation of doing so, judging from the patient's pulse, skin, or general aspect; or when, as in a rigor, or in cholera, and some other conditions, from the coldness of the surface and extremities, an inexperienced person would think a febrile heat impossible. Very high or very low temperatures may also, as a rule, be regarded as evidencing, in themselves, a dangerous condition. Hyper-pyretic temperatures occur as serious complications in acute articular rheumatism, chorea, enteric fever, and some other diseases, associated usually with great cerebral disturbance. Very high temperatures, lasting but a short time just before death, are not uncommon in various diseases. (See Fig. 1.) Very low temperatures, however, are equally or even more common just at the end. (See Fig. 2.) Collapse temperatures, as judged by the heat in the axilla, are sometimes due to a surface depression; the axilla under such circumstances does not give such a close approximation as usual to the temperature of the blood: in such conditions if we wish to know whether the internal heat is really lowered we must apply the thermometer to the rectum or vagina; but the internal temperature may also be much depressed in collapse. (See comparison of terminal temperatures in Fig. 17.) The thermometer only supplies information as to pyrexia at the given time; its indications, therefore, must be interpreted with due caution, and in view of other symptoms and of the known facts of disease.

FIG. 1



Unusually high temperature just before death; great exacerbation with a rigor.

FIG. 2.



Very low temperature in rectum just before death.

The periodicity of the temperature is one of the most interesting and important points to be considered. It has already been pointed out in connection with the time of day for taking observations that even in health, or after convalescence is established, constant oscillations are going on. An illustration of these small variations may be seen in the diagram showing the relapses in enteric fever; for a whole month the temperature was normal, but slight variations, seldom exceeding one degree F., habitually occurred. (Fig. 18, temperature during September.)

In febrile diseases also the rise of the temperature from morning to night is usually well marked—the whole range being, of course, maintained at a higher level. (See the febrile stage in enteric fever, Fig. 18; relapsing fever, Fig. 9; pneumonia, Fig. 14; and other diagrams.)

In hectic fever we have not unfrequently the morning and even the forenoon temperatures nearly normal, while at night a high degree of fever is reached. When the fever falls, but does not completely intermit or disappear at some part of the day, it is termed "remittent;" this form of pyrexia is very common in phthisis and tubercular diseases; it is also often found in some stages of prolonged suppuration. The remissions of hectic fever are well shown in the diagram, the highest of the temperatures noted in the evening and the

FIG. 3.

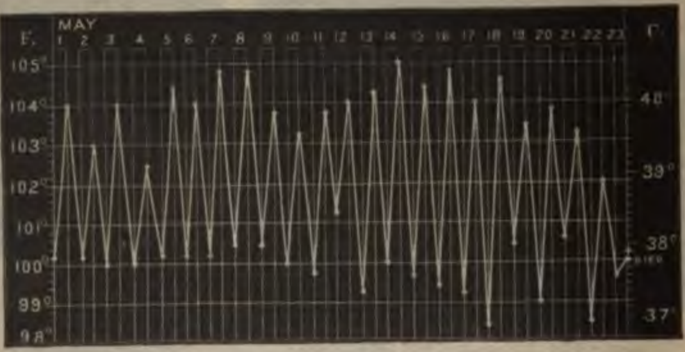


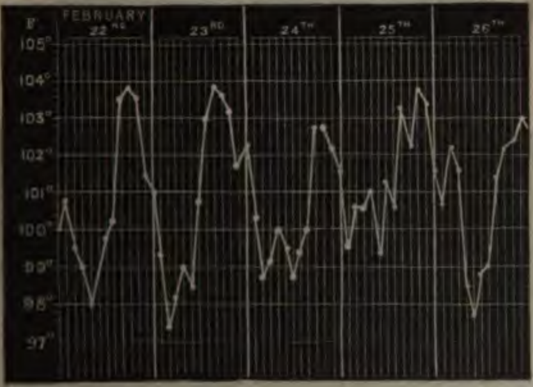
Diagram showing the daily range of temperature in a boy six years old affected with phthisis and tuberculosis; observations were made in the rectum six times in the twenty-four hours, and the maximum and minimum temperatures have been recorded on the diagram; the minimum always occurred in the morning, usually about 6 A. M., and the maximum always in the afternoon, sometimes as early as 2, usually about 4 or 6, and occasionally somewhat later.

The pulse varied from 136 to 148, and the respirations from 44 to 60.

lowest in the morning having been selected in drawing up the chart on page 80. (See Fig. 3; compare also the daily oscillations at the termination of enteric fever, as shown in Fig. 15.)

When this diurnal variation in hectic fever is studied more closely, the temperature is found to rise with considerable regularity at certain parts of the day, usually about midday or in the early hours of the afternoon. This rise is often very sudden—an elevation of three or four degrees F. may be attained within three or four hours, or even less, so that the temperature may pass from the normal level to a high fever height within that time. This daily periodicity, with a daily or quotidian paroxysm, is well shown in two diagrams from cases of phthisis. In the one (Fig. 4) the temperatures are those of a child taken every two hours in the rectum; in the other the temperatures were those of an adult taken every four hours in the axilla. (Fig. 5.)

FIG. 4.

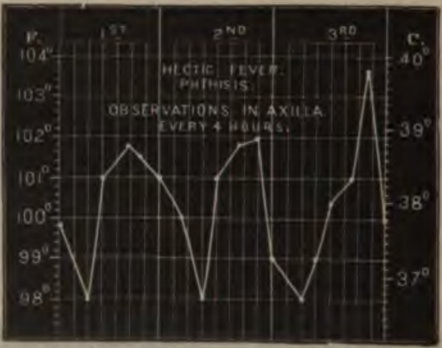


Diurnal range of hectic fever in a phthisical child. Temperatures every two hours in rectum.

In other forms of tubercular disease the type of hectic fever may be departed from, and in acute miliary tuberculosis, in particular, we not unfrequently have an approach to the type of a more or less severe continued fever, as shown in the chart from a case of this disease in a child. (Fig. 6.)

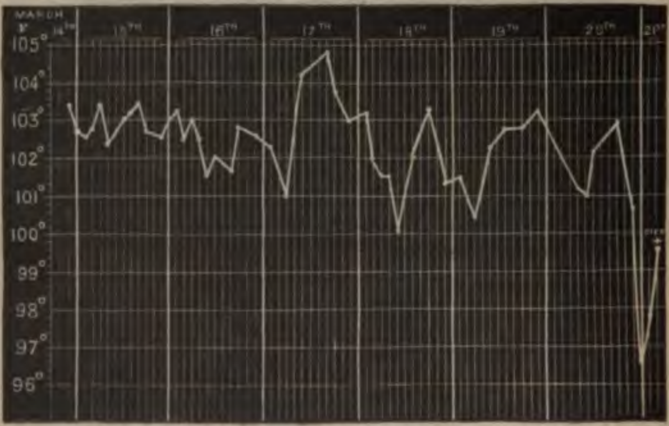
The daily paroxysm constitutes the peculiarity and supplies

Fig. 5.



Diurnal range of the temperature in hectic fever.

Fig. 6.

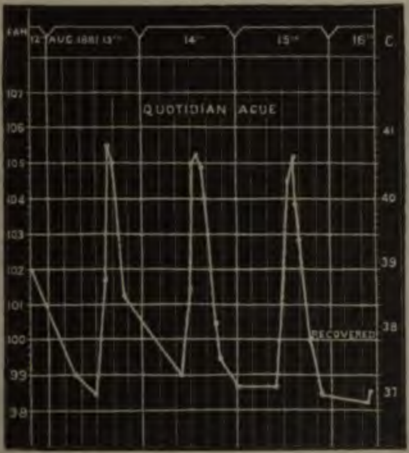


Temperatures in a case of acute miliary tuberculosis in a boy, showing the type of a continued fever. Pulse 130–160; respiration 40 to 60 and 70.

the name of that form of ague or intermittent fever termed quotidian. The regularity of the paroxysms as to time, the rapidity of the ascent and descent, and the completeness of the intermission, are shown in the accompanying temperature chart. (Fig. 7.)

The periodicity of intermittents is not, however, necessarily of the daily type. One day may be omitted; or, in other words, the intermission may last a full day: in this way the attack occurring on one day is followed by another, not on the second, but on the *third day;* hence the name "tertian" is applied to this form of ague. (See Fig. 8.)

FIG. 7.



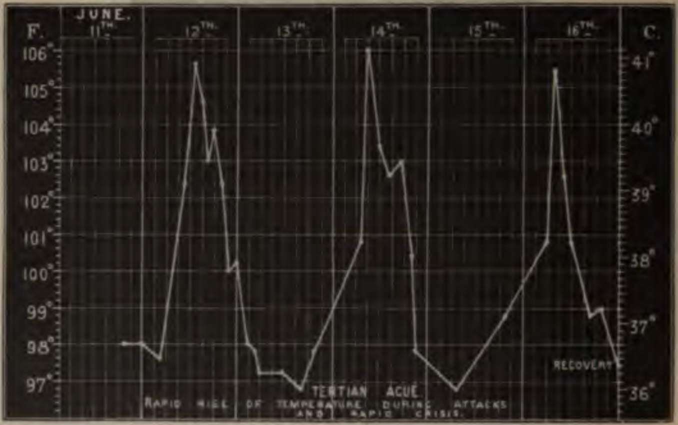
Daily paroxysms in intermittent fever: quotidian ague: temperature in axilla.

A further variation of the paroxysm in intermittents is when the fever occurs not on the third but on the fourth day—there being two days of an intermission—so that the name "quartan" is applied.

This return of the fever, after it had apparently gone quite away, sometimes assumes a different periodicity. We may have a whole week free from fever, and the patient may seem so well that if the regularity of the disease were not so well known, we could scarcely believe in the return of the whole train of symptoms on the thirteenth or fourteenth day. This peculiarity furnishes the distinctive name of "relapsing fever." This remarkable disease, called also "famine fever," has appeared in this country on several occasions in the form of an epidemic. The sudden collapse or fall of the temperature, the almost equally sudden rise at the relapse, and the week's intermission, are shown plainly in the diagram. (Fig. 9.)

The periodicity of febrile diseases is shown in the duration of the pyrexial period as well as in that of the apyretic interval. The paroxysm in a simple quotidian intermittent can only, of course, last a part of a day: the same may be said of simple forms of the tertian and other varieties also; but in bad forms the intermissions become incomplete, and the pyrexia assumes the remitting type, or even merges into a continued fever.

FIG. 8.

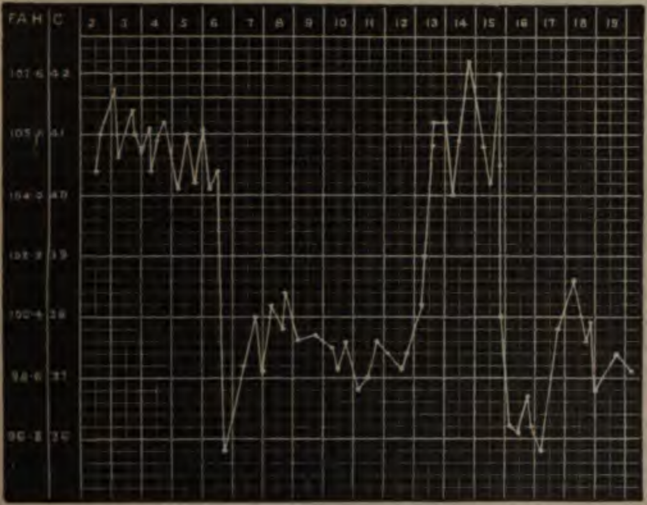


Intermittent fever: tertian ague: temperature in axilla.

In relapsing fever the duration of the pyrexia is just as definite as that of the interval, although in both a little variation occurs. The first attack usually lasts five to seven days, and the relapse three or four—the interval between them varying also from about six to eight days.

In smallpox the primary fever undergoes on the third day a material reduction, or it may be, in the modified variety, a complete subsidence, coincidently with the appearance of the eruption. (See Fig. 10.) In lobar pneumonia the pyrexia terminates with as much abruptness as in the infectious fevers; the date of the crisis, however, may vary from the third to the tenth or twelfth day. Very definite as to duration is the

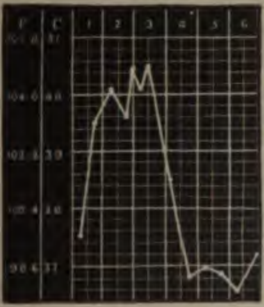
FIG. 9.



Temperature in relapsing fever (Wunderlich).

pyrexia of typhus fever, which may be stated as about a fortnight, with a margin of variation of a day or two on either side. In the case of enteric fever the period of pyrexia is much more variable, some cases terminating favorably in ten

FIG. 10.



Temperature in modified smallpox or varioloid (Wunderlich). The rapid subsidence of the temperature occurs on the third day, with the appearance of the eruption.

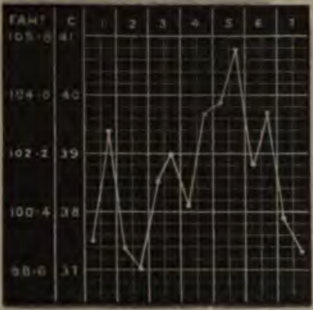
or twelve days, most of them attaining the usual period of about three weeks, and some even going on, without intermission, for five or six weeks. (Compare duration of attacks in Fig. 18.) Even this fever, however, cannot go on indefinitely; a fever course in this disease prolonged beyond five or six weeks can usually be found to depend on complications, or perhaps on relapses. These are, no doubt, sometimes difficult to detect or to prove in particular cases, although the general statement given above may be accepted. The subject of recrudescences and relapses, however, falls to be considered in another section of this chapter.

The absence of any recognizable periodicity in the pyrexia constitutes a feature of pyæmic fever which has some value in diagnosis. In this disease we may have paroxysms occurring daily, or sometimes twice or thrice in a day. These frequently coincide with the occurrence of severe rigors. No definite relationship to days or hours can be made out in such cases, the temperature running up and down in the most erratic manner, and we are sometimes afforded, on this account, grounds for suspecting the presence of this formidable disease.

Another variety of the absence of periodicity in the temperature (at least as to duration) is found in those cases where the fever course appears to be going on indefinitely for many weeks or months. In whatever way such cases may have begun, we must, under such circumstances, carefully consider the probability of having to do with some form of tubercular disease, or, it may be, with chronic suppuration.

The manner of rise in the temperature and the duration of the pyrexia, with regard to the date of the illness, are often most valuable for diagnosis. Some diseases are remarkable for the rapidity with which the temperature rises. Most of the short fevers or febriculæ, as they are called, begin suddenly, and rapidly attain their maximum. Amongst these are the surgical febriculæ (immediately after operations), and the feverish attacks, associated with obscure and often transient disturbances of the general health, due to disorders of the digestive organs, especially in childhood. The following likewise usually show a rapid development of pyrexia: Suppurations, and most of the diseases ushered in with severe rigors, ague (Figs. 7 and 8), tonsillitis, acute nephritis, scarlatina, smallpox (Fig. 10), pneumonia (Fig. 13), pleurisy, peritonitis, meningitis of the convexity, relapsing fever (Fig. 9), erysipelas, pyæmia, parotitis. All of these may have very high temperature on the first day of the illness. Occasionally in malignant cases of smallpox and scarlet fever the disease proves fatal so early that the system is overwhelmed with the poison and never shows any febrile heat. Measles sometimes almost reaches its maximum temperature on the first day of the fever, although a marked fall usually intervenes between this and the maximum temperature reached on the fourth or fifth day with the full development of the rash (Fig. 11). A great and sudden elevation of the temperature is so common in the diseases named above that they should always be thought of in doubtful cases.

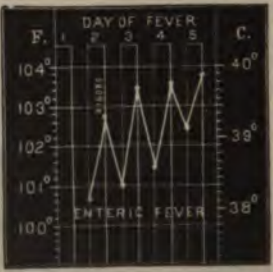
FIG. 11.



Temperature in measles (Wunderlich). Fall of temperature after the first day's fever. Great rise on the fourth day, with the appearance of rash. Maximum on fifth day, with full development of the rash.

Other diseases are rather characterized by a more gradual and progressive elevation of the temperature; this is especially observed in enteric fever (Fig. 12), although exceptional cases of this disease occur in which the pyrexia attains its maximum at what seems to be the very beginning of the illness. But in enteric fever, as a rule, the manner of rise is such that during the first three or four days every day marks an advance on the previous one, the morning temperature falling from the elevation of the previous night, but being in excess of that of the previous morning. In typhus fever the advance of the temperature is somewhat more sudden than in enteric, but in it, likewise, several days usually elapse before the maximum, or any *very* high point is reached. In articular rheumatism, affecting several joints, in catarrhal pneumonia, in acute tuberculosis, and phthisical affections, the ascent of the temperature is usually spread over several days.

FIG. 12.



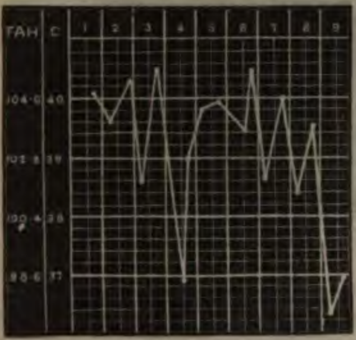
Gradual rise of temperature at the beginning of enteric fever.

The *duration* of the pyrexia often assists the diagnosis. The complete and continued subsidence of the temperature, within a week, may serve to exclude typhus and enteric fevers; its prolongation for twelve or fourteen days, without any febrile rash or any evidence of local inflammatory mischief, may sometimes guide us to the diagnosis of enteric fever (see Fig. 18 for first fifteen days); or its persistence may, in a chest complaint, lead us to the diagnosis of phthisis (see Fig. 3), or empyema. The duration of the pyrexia is also controlled by the periodicity discussed in a previous section.

The decline of the temperature, both as regards its date and manner, is of the utmost importance in prognosis and sometimes in diagnosis. The favorable termination of a febrile disease, by a rapid fall of the temperature to the normal or subnormal level, constitutes a *crisis*. This fall may amount to three or four degrees or more in twelve to thirty-six hours. This method of termination is common in pneumonia (lobar), relapsing fever, typhus, smallpox, tonsillitis, facial erysipelas, and febriculæ of various kinds. Its suddenness is represented in the diagrams of ague (Figs. 7 and 8); of pneumonia (Figs. 13 and 19); and of relapsing fever (Fig. 9). In smallpox a critical fall of the temperature occurs with the appearance of the rash on the third day (see Fig. 10), although in severe cases it may rise again. It occurs, however, in a modified and less abrupt manner in measles and sometimes in enteric fever. (See Figs. 11 and 16.) The suddenness of the crisis varies much in different diseases and even in different cases; in many cases of typhus a gradual diminution, extending over three or four days, is sometimes so distinct as to make the crisis in this disease much less pronounced than is usually taught, and to assimilate it rather to a lysis; frequently, however, the critical fall of the temperature is very marked.

Lysis is the term applied to a more gradual diminution of the fever, spread over several days; this may usually be observed in scarlatina and broncho-pneumonia, occasionally in pleurisy and pericarditis, and also in acute rheumatism. The defervescence in the two forms of pneumonia is usually strongly contrasted; in lobar or croupous pneumonia we have a sudden crisis; in catarrhal or broncho-pneumonia we have usually a lysis. (See Figs. 13 and 14.) Sometimes the lysis assumes a remitting character, the morning temperatures falling gradually or suddenly, and the evening temperatures preserving for some days nearly their former elevation. This is not uncommon in enteric fever. (See Fig. 15; compare, also, the gradual descent of the temperature in the three attacks shown in the diagram of enteric fever, Fig. 18.)

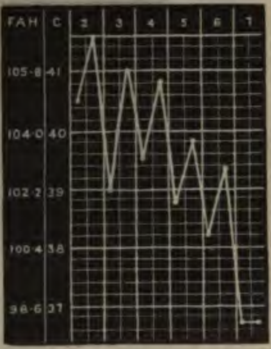
FIG. 13.



CRISIS.

Temperature in lobar pneumonia (Wunderlich). Sudden crisis on eighth day; pseudo-crisis on fourth day.

FIG. 14.

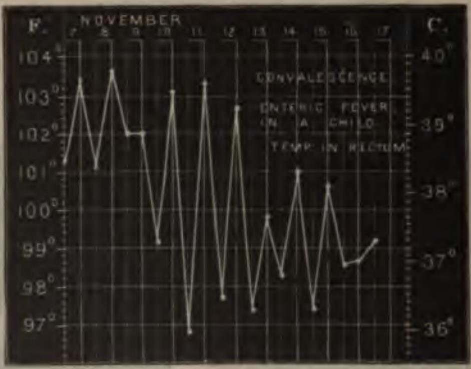


LYSIS.

Temperature in broncho-pneumonia (Wunderlich). Gradual fall extending over four days.

Certain fallacies beset the estimation of the value of a fall of temperature. It is very often found that a high, febrile temperature undergoes a great diminution on the day after admission to the hospital; this seems often to be really due to an unusual elevation on the day of admission, arising from the disturbance of moving the patient, etc., so that little weight is attached to the temperatures of the first day's residence in

Fig. 15.

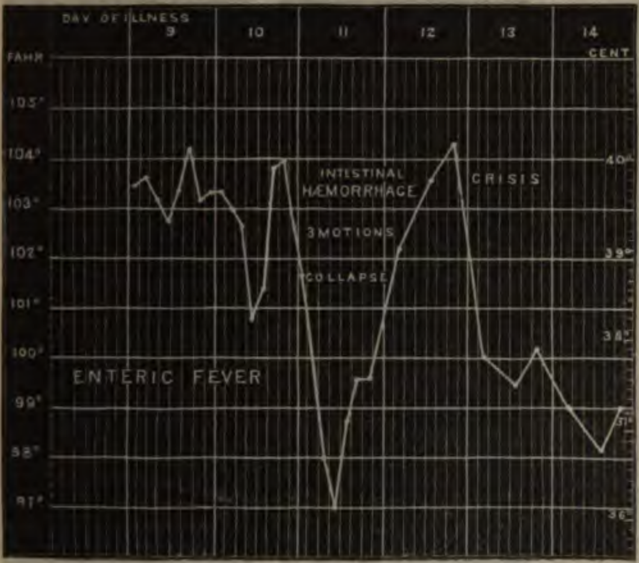


Remitting lysis in enteric fever.

hospital. Occasionally a *pseudo-crisis*, as it is called, occurs a day or two before the real crisis, the temperature, after being low for a few hours, mounting up again to its former height; this *pseudo-crisis* affords no guarantee of a subsequent genuine crisis. (See Fig. 13.) Collapse temperatures may stimulate a crisis, although really indicative of serious complications, as in the intestinal hemorrhage of enteric fever, where the cause of the fall may not always at first be quite apparent. (See Fig. 16.) The fatal termination of some cases of febrile disease is often associated with a marked fall in the temperature, and occasionally this occurs under such circumstances as to simulate an improvement. (See Fig. 17; compare also Figs. 2 and 6.) Collapse temperatures may occasionally be detected for a few hours in the midst of a raging fever, or just before the terminal exacerbation of a febrile disease, whether it be favorable or fatal. Sometimes the decline of temperature in a tubercular subject is connected with the supervention of cerebral complications. (See Fig. 20.)

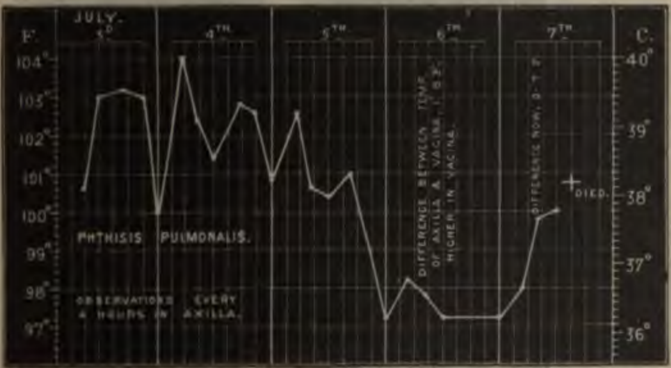
Recrudescences; relapses; complications. *A reascent of the temperature*, after a more or less complete subsidence, may be

FIG. 16.



Collapse of the temperature in enteric fever, due to intestinal hemorrhage on the eleventh day—an accident which usually occurs later in the illness. The crisis in this case was unusually sudden.

FIG. 17.



Collapse of the temperature simulating an improvement. The relatively excessive depression of the axillary, as compared with the vaginal, temperatures was noted during the collapse, both sets being taken with great care. A diminution of the *difference* occurred with the rallying of the temperature.

Temperature in a Case of Enteric Fever with Two Relapses. Unusually Long Interval between the Primary Fever and the First Relapse.

Fig. 18.

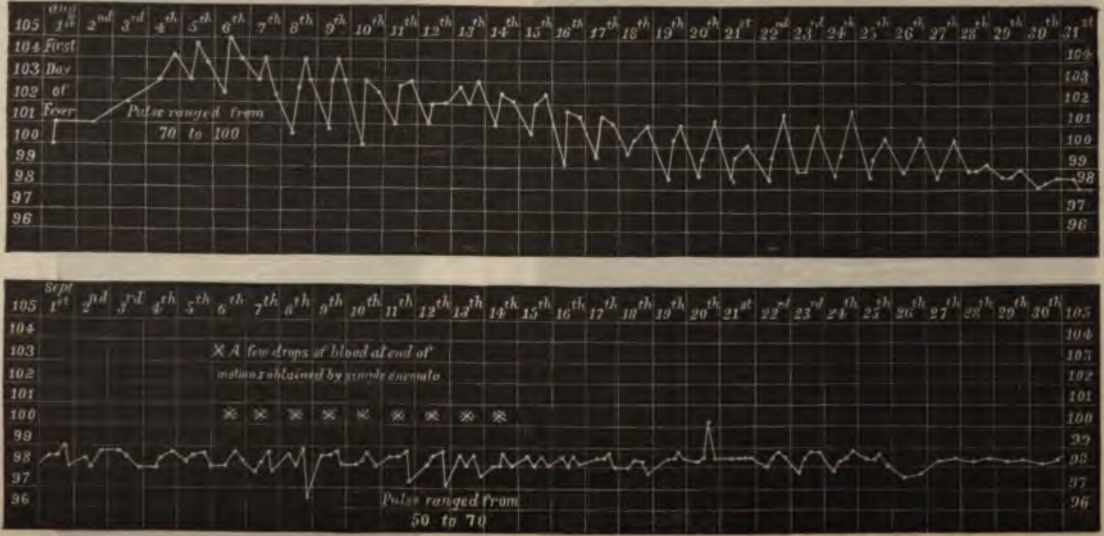
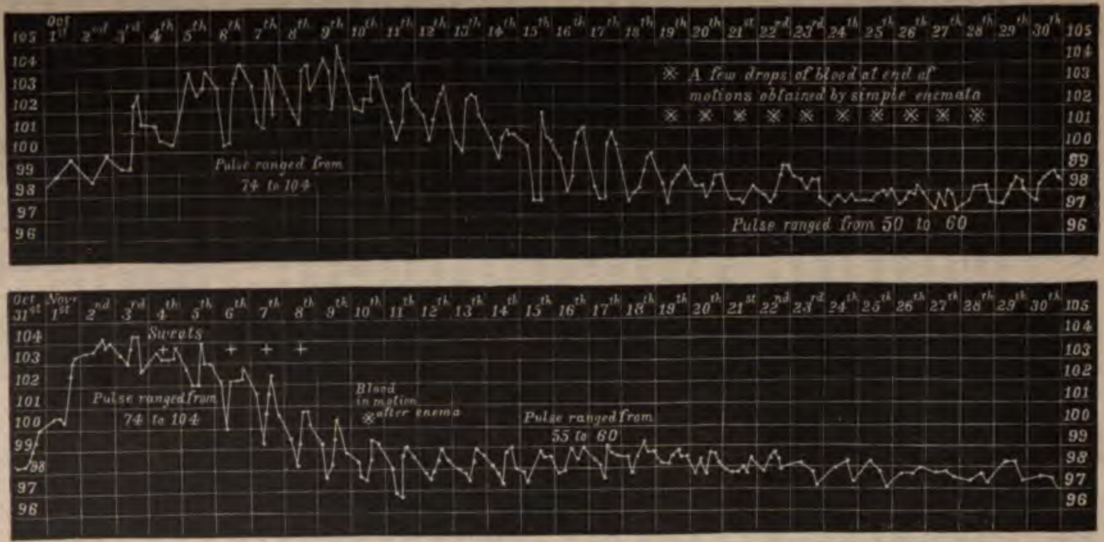


FIG. 18—Continued.



NOTE.—(1) The gradual rise at beginning of attack (August) and the more rapid ascent in the relapses (Oct. and Nov.). (2) The daily range with evening exacerbations in the febrile periods. (3) The normal level in the apyretic period with only slight daily oscillations. (4) The defervescence (lysis) very gradual in August, pretty rapid in November, intermediate in October. The remitting character is seen in all; very marked from October 15th to 19th. (5) The duration of the fever about four weeks in first attack, three in second, and nearly two in the third. (6) The long interval between the primary attack and the first relapse is quite unusual; the common length of the interval is seen between the relapses.

due, as already explained, to the peculiar periodicity of the disease. In other cases, however, we find it to be due to a "*recrudescence*" of the fever. By this term is meant a reascent of the temperature after a defervescence which from its extent or its duration cannot be regarded as complete. Such exacerbations often depend on the extension of the mischief; for example, from new portions of the lung being involved in pneumonia, or to advancing intestinal ulcerations in enteric fever. Such recrudescences are distinguished from "*relapses:*" the latter only occur after a definite period of complete apyrexia. Theoretically the distinction made is that in recrudescences we have merely the extension or aggravation of mischief already existing: in relapses we have new mischief *ab initio.*

Enteric fever is particularly liable to both, and in this disease we would expect to find new or recent deposits in the intestinal glands at the date of a relapse. No doubt if these fresh deposits in a relapse occur before the subsidence of the first febrile attack, we may have an overlapping of the first febrile period by the second: in this way a relapse might appear to affect the temperature after the manner of a recrudescence; and in such a case nothing but a careful post-mortem examination, if the illness proved fatal, could settle the distinction. True relapses in enteric fever occur after an interval of a few days perfectly free from pyrexia, and when the patient appears in other respects to be recovering; usually this interval is about a week or less, but ten or twelve days are not uncommon. A diagram is here given showing a very prolonged period of intermission—a full month—between the first and the second attack. This length of interval is very exceptional, but the evidence of its reality is complete; if the temperature had not been taken so carefully during the prolonged interval it might have been plausibly contended that a relapse had occurred during this month of such a slight nature as to have escaped recognition, and this is a thing which should be remembered as quite likely to occur. Between the first and the second relapse, in this same case, the apyretic period was of the usual duration of eight or ten days. (See Fig. 18.) The rise of the temperature at the beginning of a relapse in enteric fever is much more sudden than in the same stage of the first attack. (See Fig. 18; compare temperatures at the beginning of August with those at the beginning of October and November; compare also Fig. 12.)

The reascent of the temperature may be due to *complications.*

These may occur at any stage of an illness or after convalescence is established. In any case, whatever may be the usual mode of onset of the disease under other circumstances, the rise of temperature with the complication is usually abrupt. Complications may also, by their presence, delay a crisis, as is often seen in bronchitis complicating typhus, and in this way prolong the illness; or the complication may impress a remitting character on the fever, as is seen in the hectic fever of phthisis, sometimes developed in a case of pneumonia or pleurisy in a tubercular subject. The temperature of convalescents, however, it must be remembered, is very unstable, and there is often a serious-looking disturbance of the temperature in them from very slight causes (indigestion, constipation, fatigue, excitement, etc.), which would not thus affect the healthy. For this very reason, temperature observations in this stage are highly important, as affording the best evidence of continued safety or the first alarm of threatened danger.

From what has been said, it will be seen that the temperature, although of the utmost importance in diagnosis and prognosis, must not be regarded too exclusively, or apart from the other facts of the case and the general state of the patient. The natural course of the temperature in the various diseases, as ascertained by experience, must be kept in mind; a degree of elevation or a special behavior of the temperature may have a very serious significance in one disease and very little in another. The comparison of the temperature with the pulse often serves to correct our views of each, and although they usually rise and fall together (see Fig. 19), certain deviations occasionally or habitually occur in special diseases, or in certain stages of such affections, which are of the greatest significance; (for example, at the beginning and the end of enteric fever, and toward the end of tubercular meningitis; see Fig. 20).

Surface Thermometers.

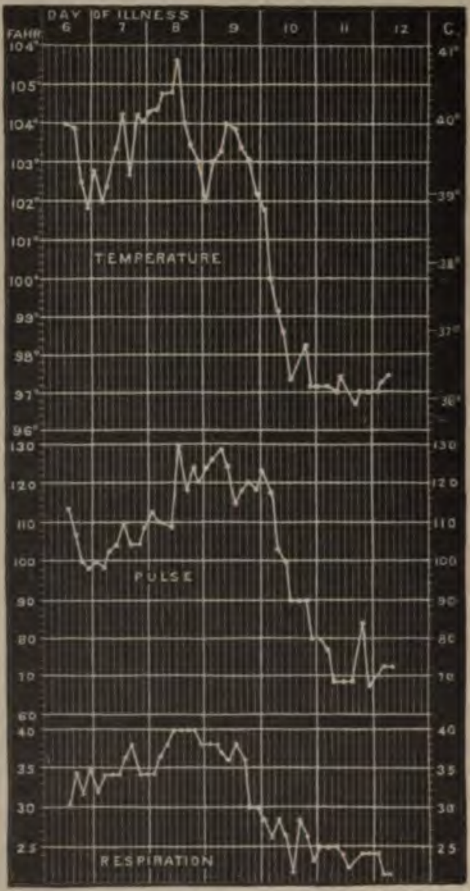
In the preceding sections the ordinary clinical thermometer is supposed to be applied in such a way as to give us an approximation to the heat of the blood. Surface thermometers are used to give an estimate of local or surface temperatures. They are made with broad or spiral bulbs so as to expose a large surface to the part tested, and these bulbs are enclosed in small cavities, ingeniously made, so as to lessen the loss of heat when applied. They are sometimes sold in pairs, so that two parts, or two sides of the body, may be tested simultaneously. Hitherto their use has not been very extensive, nor have the results so far obtained been very important. They enable us, however, to record in figures differences in local temperature which may be appreciable in other ways, as in cases of obstructed arteries in limbs, atrophic infantile paralysis, local inflammation or hyperæmia, etc. The difficulty in using them depends on the length of time required to heat up the air chamber containing the bulbs of mercury: on the variation in the results obtained, within similar periods of time, according as the instrument is pressed more or less firmly on the part if the thermometer is tied: on the heat of the hands of the observer complicating the result, if the instruments are held by him; and apparently also on a prolonged application, carried to the extent of obtaining a stationary condition of the mercury, ceasing to afford a true *surface* temperature, and yielding rather an approximation to the internal heat, from the part being so long covered over by the instrument. It seems best to use a pair of instruments (carefully compared), so as to have the applications simultaneous, if differential observations are required; otherwise the loss of time and the altered conditions of heat render the results obtained by the transference of the same instrument from one part to another very uncertain. In applying them they should be held in an exactly similar manner, and pressed with as nearly as possible equal firmness. Moreover, the readings from minute to minute during the rise of the mercury should be noted in each instrument, as the difference in rapidity of the rise appears to indicate the surface temperature in a more striking manner than the figures ultimately attained. In checking the results by a second application, the instruments may be changed so as to be applied to different sides.

THE PULSE

affords such valuable indications for the determination of the febrile state, and for estimating the general strength of the patient, that the noting of it is a matter of routine in all cases. Apart from fever, however, there are other important points to be attended to in noting the pulse, and to prevent repetition these also will be considered here.

The frequency of the pulse is not difficult to estimate; the pulsations in the artery, the radial by preference, are counted for a quarter or for half a minute, with the aid of a watch furnished with a seconds dial, and the number per minute is thus calculated. For delicate inquiries, the pulse should be counted for a whole minute, or even for two consecutive minutes, the number being halved of course in stating the result. Other points also must be attended to when accuracy is desired. The normal rate of the pulse varies with age, and also in different individuals (according to temperament); in the adult it is usually stated as being about 72, but it is sometimes higher and often much lower: it is more rapid in childhood, and in infancy is often about 100, apart from disease. In the same individual the pulse varies with position, both in health and disease, the rate being higher when the patient is standing than sitting, and higher while sitting than lying down: any movement or exertion tends to increase the rate, and mental excitement is particularly apt in some people to make it rise very high. Hence, in estimating the pulse or its changes from day to day, in such a delicate inquiry, for example, as the estimation of an incipient defervescence, care must be taken to have results really comparable, and not to compare the rate of the pulse while the patient is sitting up in bed with that obtained on a previous day while he was lying still. The influence of meals is also very great, the pulse rising considerably after a full meal, and especially after the use of stimulants in the healthy state; in febrile diseases, however, the effect of stimulants is often to reduce the pulse-rate when their influence is beneficial. Apparently the habitual use of spirits for years tends to keep up a persistently high pulse-rate natural to the individual, quite apart from any febrile disease or any special excess. The time of day has a certain influence in the normal state, even apart from food and exercise; the pulse-rate, like the temperature, is lower during the midnight hours, and rises in the early morning, but the exact time of these changes varies; they are usually later if occurring in febrile diseases than in the normal state. Sleep has a tendency to reduce the pulse-rate. Considerable tact is often required to secure a fair estimate of the pulse; in some cases we obtain the best chance at the beginning of our visit, counting the pulse before the patient is disturbed in any way by speaking or moving; or perhaps, especially in children, during the quietness of sleep. With some patients, again, the approach of a stranger sets up the pulse to such a height that we must wait till it has subsided. The lowest rate we can obtain is the most reliable index in judging the degree of fever. A fit of coughing, or the exertion of moving or sitting up for the purpose of auscultation, etc., often completely spoils the value of the pulse-rate as a gauge of pyrexia. It is in such cases that temperature observations come in as a valuable check (see "Temperature"), and these often assure us that the rapidity of the pulse is due to excitement, general weakness, or irritability of the heart, apart from fever. As a rule, the pulse and temperature in febrile cases are elevated or depressed, and rise and fall together (see Fig. 19); but striking differences occur in certain cases. The pulse is often but little elevated in the beginning of enteric fever, at a time when the temperature is very high; while after the recovery has begun, the pulse may be rapid from weakness, although the fever temperature has completely fallen. And in some patients, with febrile or inflammatory disease, the pulse is

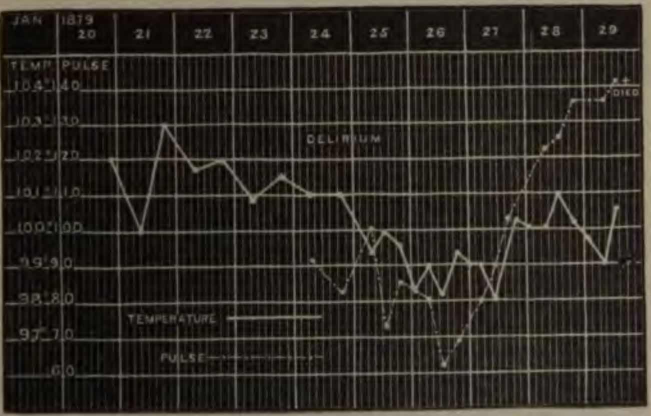
FIG. 19.



Crisis in lobar pneumonia: the diagram shows the sudden improvement in temperature, pulse, and respiration almost simultaneously.

often quite normal in rate, although the temperature is persistently high. On the other hand, in incipient phthisis, we may have a constant elevation of the pulse with but little change in the temperature. In cerebral cases, also, the relationship of the pulse-rate to the temperature is subject to special variations; the terminal stage of tubercular meningitis is often characterized by a high pulse and a comparatively low temperature. (See Fig. 20.)

FIG. 20.



Subsidence of a high temperature from phthisis on the supervention of tubercular meningitis: the time when cerebral symptoms occurred is indicated by delirium noted on the chart. The pulse, which fell at first with the temperature, ran up toward death, although the temperature remained comparatively low.

The ratio of the pulse-rate to the frequency of the respiration, is sometimes of value as an index of the existence or supervention of respiratory disease; for although a little acceleration of the respiration is natural in the febrile state, any great disturbance of the *ratio* usually points to such complications. (See "Respiration," Chapter IX.)

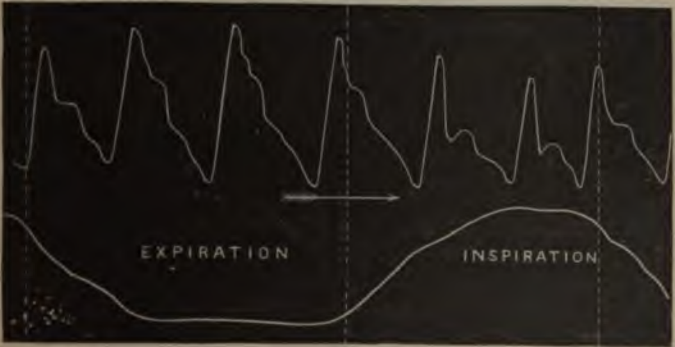
Slowness of the pulse has been just referred to as an exceptional occurrence in the febrile state in the sense of there not being the usual acceleration. We sometimes find, however, an absolute reduction in the pulse-rate in certain diseases; 40 to 50 beats are not uncommon, and we may have 30, 20, or even less. These low numbers are sometimes due to the effect of digitalis used medicinally. In fatty degeneration of the muscular fibres of the heart a very low pulse-rate is an important sign of this condition. Occasionally in epileptics the pulse is very slow; and in various brain diseases, particularly when there is pressure or effusion, the pulse-rate falls; this fall, however, may be followed by a terminal exacerbation. (See Fig. 20.)

The force or strength of the pulse often guides our prognosis, and directs us in the treatment, especially as regards stimulants. It is not easily estimated by the beginner; it requires experience and the watching of cases (especially febrile cases), from day to day, for the education of the fingers. Sometimes the radial pulse gives a fallacious idea of weakness, from the vessel being of unusually small size (high division or other abnormality). Pressure on the arm from the patient's position in lying on it, or some accidental tightness of the dress, may also interfere with the radial pulse. Moreover, the radial arteries on the two sides are often of very different size, and so we find that errors sometimes arise from our detecting a difference due merely to an accidental change in the method of observation—the other arm having, perhaps, been taken instead of the one usually felt. In doubtful cases the radial, brachial, or other arteries on *both* sides should be examined, and the heart's sounds should be listened to.—When the pulse is really very weak, the first sound of the heart is usually diminished and sometimes almost suppressed, the second sound remaining distinct. Differences in the strength of the two radial or other pulses are often of value in diagnosis, particularly in cases of aneurism of the arch of the aorta, giving rise to more or less obstruction of certain branches. Sometimes the two pulses are not perfectly synchronous from similar causes. Occasionally, also, the diminution or obliteration of an arterial pulse serves to indicate the occurrence of embolism, but care must be taken to see that these differences are not due to unusual distribution of the vessels. A survey of the arteries should be made, both with the finger and eye, when judging of the force of the pulse, and the examination should not be limited merely to the part of the radial artery at the wrist; by extending our observation we may detect any undue rigidity, twisting, or unevenness of the vessels. Sometimes other arteries must be examined to satisfy ourselves on this subject; the temporals and the branches of the thyroid axis are selected for the purpose of testing the smaller vessels, the brachials and the femorals as a sample of the larger.

The hardness of the pulse-beat must be distinguished from the hardness due to the state of the arterial walls just referred to. The walls may not be rigid and yet the pulse may feel like a cord. This is an indication of high arterial tension, and is often noticeable in various forms of Bright's disease, and particularly in cases of the contracted kidney.

The rhythm of the pulse is in health perfectly regular, so that any deviation from this should be noted. Sometimes there is a distinct intermission, a loss of a beat at regular or irregular periods, but there may be such a loss in the radial pulse without any corresponding intermission in the heart's sounds or action; there may thus be a marked difference in the pulse-rate as counted at the wrist and at the heart, the strength of the cardiac contraction being unable to produce a proper beat at the wrist: such abortive beats, may sometimes, however, be recognized by sphygmographic tracings. (See "Sphygmograph," Chapter XVI., under "Irregularity.") Or the irregularity may consist of two or three hurried beats followed by a succession of slower ones, or we may have the occasional occurrence of one or two weak or almost suppressed beats. Sometimes the pulse-beats vary greatly in strength through-

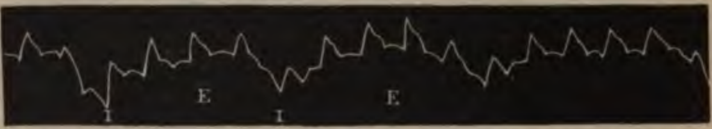
FIG. 21.



This diagram, from Foster's *Physiology*, shows the influence of the respiration on the pulse in a healthy subject. The upper tracing is the pulse. The lower curve gives the movements of the chest wall. During inspiration the pulse-waves diminish in height and become more dicrotic, while during respiration the height of the pulse-waves is increased, while their form tends more toward that of a pulse-wave with a raised arterial pressure. This diagram shows *one* form of the effect of the respiration on the pulse, but this effect varies considerably in different experiments and under different conditions. (Foster.)

out a given minute, without any intermission or marked change in the rhythm. This change in the strength and character of the pulse can be made out in certain cases to be associated with the respiratory movements, or with the occurrence of convulsions, or some other visible phenomena. (See Figs. 21 and 22 for illustrations of this in healthy and diseased states.)

FIG. 22.



This sphygmographic tracing was taken by Dr. Gemmell from a case of uræmic coma with stertorous breathing. The variations shown coincide with the respiratory movements. *I* corresponds with inspiration and *E* with expiration.

The significance of irregularity of the pulse is most varied. It sometimes affords one of the first indications to brain mischief, especially in children, or of incipient pericarditis. It is very common in various forms of heart disease, at all ages, especially in mitral disease, fatty heart, and the degenerations incident to old age. Apart from these, however, it is often due to functional disturbances, especially such as are associated with indigestion, flatulence, excessive smoking, etc. It is likewise developed, not unfrequently, through nervous agitation, in certain persons, just as acceleration of the heart's action or fluttering is produced in others from the same cause; concentration of the attention on the intermission is apt in such cases to increase the irregularity, or the frequency of the intermission. Some persons, apart from any medical knowledge, have an obscure sensation of the intermission, which causes a start or a shock. A more serious form of disturbance occurs in the intermittent pulse of typhus fever and other grave diseases; this is almost always a sign of danger from failure of the heart, but here also exceptional cases occur, of less grave import, due to the peculiarities of the individual, or to his habitual liability to this disturbance. An intermission in the pulse sometimes marks the beginning of the epileptic fit. In states of debility, during convalescence from serious diseases, and in the case of children after enteric fever, for example, intermission of the pulse is sometimes associated with unusual slowness, and is specially noticeable at night.

This does not imply any real danger, and, indeed, in children who are practically healthy intermission of the pulse may often be detected during their natural sleep.

Dicrotous pulse.—Somewhat allied to the rhythm is the curious double beat in the pulse sometimes felt in febrile cases. It is not uncommon in the convalescence from typhus fever. This is best felt by applying the tips of the fingers very lightly over the vessel, avoiding any such pressure as would extinguish the weak second beat. The sphygmograph brings out this dicrotism very clearly. Another form of double beat, with the beats more distinct and more closely together, has been named the "pulsus bigeminus." These peculiarities are best discussed in connection with the sphygmograph. (See Chapter XVI.).

The pulse of unfilled arteries, characterized by a sudden filling up of the artery followed by a very sudden collapse of the vessel under the finger, often enables us to suspect, or sometimes even definitely to recognize, incompetency of the aortic valves, on feeling a patient's pulse. The peculiarity is brought out in a more striking way by raising the patient's arm vertically while feeling the radial pulse; visible pulsation throughout the arteries and especially in the neck is usually very marked. This is also spoken of as the "water hammer" pulse from its sudden slapping or jerking character; "the pulse of aortic regurgitation" from its cause; and "Corrigan's pulse" from its describer. It also occurs in thoracic aneurism.

(For *capillary and venous pulse*, see Chapter XVI.)

A thrill in the pulse can often be felt in certain cases of cardiac disease (mitral and aortic valvular disease), and this may come out in the sphygmographic tracing.

The sphygmograph gives important aid in the study of the pulse. Its indications have a certain value in diagnosis, but in addition to this a little practice with it has great educational value to the student in enabling him to recognize by his fingers many of the peculiarities of the pulse which it records. It seems best, however, to discuss it in connection with the physical diagnosis of the heart, of which it forms an important part. (See Chapter XVI.)

General or Constitutional Indications of the Febrile State.

In addition to an increased temperature and a rapid pulse, there are certain general signs of fever which are of great value. *Flushing of the face* is common in fever, but care is required to prevent mistakes in judging of this, as the color of the cheeks varies much in different persons, and such an accident as lying on the cheek often produces a local flush, apart from fever; in such cases the thermometer is an invaluable guide. *Sweating* is habitual in rheumatic and enteric fever, and in the disturbances of the puerperal state, and is common in certain stages of most febrile diseases; the total absence of sweat, giving the sense of a dry pungent heat to the hand as applied to the skin, is an important fact in the height of fevers, pneumonia, etc. The critical sweats after the height of the fever in ague is passed, or during the crisis of relapsing fever, are only extreme illustrations of the common combination of sweating with the subsidence of a febrile temperature. The sweating is sometimes of daily occurrence, as in the night or early morning sweatings of phthisis, coinciding with the diurnal variation of the temperature; it is also often cold and clammy, and in such cases it may be associated with bad dreams; this combination is common in cases of deep-seated suppurations, disease of the bones, etc. The profuse sweatings of pyæmic affections may also be referred to here. The influence of remedies in favoring or checking sweating, the nature and amount of the clothing and the softness of the bed are details to be kept in view in judging of special cases. Great liability to sweating on but slight exertion is a common indication of weakness quite apart from the febrile state. Sweating is sometimes local, as of the head in rickets; or of one side of the body, in certain affections of the sympathetic nerve, sometimes apart from any other obvious disease, and sometimes connected with aneurismal or other tumors in the chest or neck; the influence of nervous emotion in the production of sweating is proverbial. *Headache and pain in the back* are very common in nearly all the acute specific fevers at their beginning, and one or other is usually present, more or less, in all febrile states. Pain in the back is very specially pronounced in cases of smallpox. (Of course, these pains are often due to quite different causes, see Chapter VI.) *Unequal distribution of heat*, a feeling of heat in the head and of cold in the extremities, a burning heat in the hands or the feet, a sensation as of cold water trickling down the back, a feeling of chilliness increased on any exposure to a slight draught of cold air, and actual shiverings in all degrees of their severity are exceedingly common in the beginning of febrile diseases, especially before the patient has taken to bed; these sensations often lead him to hang about the fireplace, complaining of cold, although his temperature may be very high; they tend to disappear when, by proper heating and clothing in bed, the temperature of the various parts of the body becomes more equalized. Young children seldom have distinct shiverings. While shiverings are common at the beginning of all acute inflammatory and febrile diseases, they are especially frequent and repeated in ague, in serious suppurations, in renal inflammation, paroxysmal hæmatinuria, and renal colic, in cases of gall-stones, in puerperal fever, and in embolism and pyæmia. The passage of instruments into the bladder often determines a violent rigor with febrile disturbance. Rigors also occur occasionally in connection with sudden defervescence. Many of the sensations just referred to, and even actual shiverings, may occur apart from fever altogether in nervous subjects; the thermometer is here, again, invaluable. *The digestive functions* are almost always impaired in febrile diseases, and especially at the onset of the specific fevers: vomiting is very common in them, and is sometimes very severe and persistent (smallpox, scarlatina, relapsing fever, and occasionally enteric fever); in other cases sickness or nausea is all that is complained of. The appetite is almost always impaired, and often completely suppressed. The bowels are usually disordered; the febrile state tends, as a rule, to produce constipation, but occasionally diarrhœa is seen to result from the action of the specific poison (as in the beginning of malignant scarlatina), and sometimes there is a special connection between the diarrhœa and the febrile disease (as in ulceration of the bowels in enteric fever, in the inflammatory diarrhœa of infants, and in tubercular and dysenteric ulcerations); at times, however, the looseness of the bowels seems related to the pyrexia as such, and ceases with it: or it may be due to the concurrent impairment of the digestive functions and their inability to deal with the food forced on the patient in his febrile state. The state of the tongue is usually a good index of the constitutional disturbance produced by the fever, so far as the digestive organs are concerned (see "Tongue," Chapter XI.). Thirst is almost always present in the febrile state, especially at the beginning of the illness, and notwithstanding the large amount of fluid swallowed, the urine is usually scanty and high-colored. *Muscular prostration* is present in all severe cases of fever, and is often very marked even at the very beginning of some of the specific fevers. *Delirium* is usually associated, in very varying degrees however, with high ranges of pyrexia from whatever cause; the degree of it, and the date at which it appears, as well as its character, vary much in different diseases. *Convulsions* sometimes take the place, as it were, of delirium, especially in young children, and often mark the beginning of acute inflammatory or febrile diseases in them. A degree of *bronchial catarrh* is not uncommon in nearly all serious febrile states, and is a special feature in some. *Cutaneous eruptions* are characteristic of certain febrile diseases (see "Febrile Rashes," p. 137): various symptoms referred to above are dealt with more fully elsewhere (see Index).

The Clinical Significance of the Febrile State is very great, and this remark applies both to the presence and absence of this state in a given case. It has already been explained how the febrile state is to be judged of; the possibility of our observation occurring in an apyretic interval must be remembered before we arrive at a negative conclusion. Sometimes the fact of fever (*i. e.*, pyrexia) is all that can be made out; but without denying the existence of the old "simple continued fever," we are seldom justified in resting satisfied till we either have referred the pyrexia (1) to one of the specific fevers (typhus, scarlatina, ague, pertussis, etc.), or have ascertained that it is symptomatic (2) of some special inflammation (pneumonia, pleurisy, abscess, rheumatism, etc.), or at least (3) of some disease known to be associated with febrile disturbance (phthisis, tuberculosis, syphilis, septicæmia, etc.).

(1) *Specific Fevers and Rashes.*—In determining the question of fever, attention must be directed to the presence or absence of the "rashes" found in most of the specific fevers (see p. 130). These must be carefully searched for in their favorite situations, and the date of the illness must be considered particularly as to whether there has been time for the appearance of the rash. As the exact date of the illness is often obscure, and as the day on which a febrile rash appears deviates occasionally from the average, some little allowance must often be made for such variations before arriving at a decision. The occasional absence of the rash, in nearly every fever usually characterized by an eruption, must also be remembered. Other circumstances often render the existence of such fevers very probable, or indeed certain, even when no rash has appeared. In examining for a febrile rash, other cutaneous eruptions (not of this class) may be detected, and it must be considered whether the eruption discovered is of the kind and of the extent to account for, or to be in harmony

with, the febrile movement. Some "skin diseases," as they are called, are associated with much fever, others with little or none. The possibility of an eruption from the use of medicines, and the influence of certain articles of diet must be kept in view (see "Eruptions from Medicine and Food," p. 124). Moreover, when there is high pyrexia, a certain congestion of the skin, especially in the dependent parts, sometimes simulates a scarlet rash. Eruptions indicative, so far, of certain diseases, although they cannot be called specific, are sometimes found in the febrile state—such as herpes labialis in pneumonia, or miliary vesicles in enteric and childbed fever, rheumatism, etc. Occasionally a rash is found in diseases not usually characterized in this way—thus we may have a rash in diphtheria and relapsing fever, and in the early or pre-eruptive stage of smallpox and enteric fever.

(2) *Inflammations.*—When no specific rash exists, and no distinct history of contagion is suggested, search must be made for signs of inflammation, and although the case may be admitted to a medical ward, the possibility of superficial inflammations or abscesses, periostitis, otitis, parotitis, and other glandular inflammations, must never be forgotten, especially in the case of children or those unable to express their sensations. Tonsillitis, quinsy, pharyngeal abscess, scarlatina, and diphtheritic sore throat must specially be remembered in this connection. Pain and its situation usually guide us to these and similar inflammations, and also to articular or muscular rheumatism. Regarding internal inflammations, the importance of examining the chest cannot be overrated, as we often find there the explanation of the febrile disturbance. This must never be neglected. Inflammations of other internal organs usually indicate their existence by pain over the parts, or by changes in the excretions, or by other alterations in the functions, such as paralysis, delirium, etc. A systematic search must be made into the state of all the important organs before arriving at a negative conclusion.

Shiverings are common in various febrile diseases, especially at the beginning; but when severe and recurring, the idea of suppuration somewhere is suggested, or the presence of stones in the kidney or gall-bladder, or perhaps embolism and pyæmia. Such suppurations may be in parts beyond the reach of our diagnosis, but search must be made for tender regions in the principal organs, and also in the joints, and for pus in the excretions.

(3) A miscellaneous group of diseases having certain rela-

tionships with the specific fevers and inflammations, but not definitely belonging to either, still remains. It is impossible to enumerate them, but traces of their presence will usually be found on systematic examination of the patient. Care must be taken not to conclude at once that the febrile state is due solely or chiefly to the inflammation which we may thus detect by our examination. For example, bronchitis is an habitual accompaniment of typhus, and pneumonia is common in many fevers. Inflammation or congestion of the kidneys (with albuminuria) is a frequent complication in many complaints. It is often difficult to know whether we have to do with a primary, a secondary, or a mere coincident inflammation; the date of the illness, and the known characters of the disease, often assist us, and the want of correspondence between the apparently slight extent or severity of the inflammation and the intensity of the fever, sometimes leads us to suspect that there is something behind the local inflammation.

The temperature in disease is now discussed more or less fully in all systematic works on medicine, and also in treatises on special diseases. —Wunderlich, Medical Thermometry, translated for the New Sydenham Society, London, 1871: this work contains a mass of information as to the general behavior of the temperature, and details and references bearing on special diseases also —Murchison, The Continued Fevers of Great Britain, 3d edition, by Dr. Cayley, London, 1884.—The pulse is discussed fully in many works on physiology, see especially Landois, Text-book of Human Physiology: translated with additions by Dr. Wm. Stirling, 2 vols., London, 1885.—Byrom Bramwell, Student's Guide to the Examination of the Pulse and the Use of the Sphygmograph, 2d edition, Edinburgh, 1883.—See also Chapter XVI. of this manual, where further information and references regarding the sphygmograph may be found.

CHAPTER IV.

SKIN—HAIR—NAILS—GLANDS—JOINTS—BONES.

CUTANEOUS ERUPTIONS.

ERUPTIONS on the skin are sometimes brought prominently under our notice as the chief part of the patient's complaint, or, at least, are so obvious that they cannot be overlooked; but in other cases we have to search carefully for an eruption of which the patient may be unconscious, or which he may regard as quite trivial and accidental. Most of the cutaneous eruptions serve to indicate the presence of some more or less serious poison in the blood, or of some constitutional affection or tendency to disease. Thus the eruptive fevers present on the skin the evidence of a general disturbance of the whole system. The occurrence of an early or late syphilitic eruption likewise reveals a constitutional affection, and the same may be said of scrofulous, and perhaps also at times, of cancerous diseases of the skin. The pigmentations of pregnancy and Addison's disease, the blotches in scurvy and purpura, and the influence of certain medicines in producing eruptions of various kinds, all indicate the same thing. Eczema and psoriasis, from their symmetrical distribution, their tendency to recur, and their association with certain other diseases in the patient himself, or in his family, can usually be shown to be much more than mere local diseases. Even parasitic affections of the skin often owe their rapid development and persistency to the general state of the health: the vegetable parasites do not seem to find a suitable nidus in perfectly healthy subjects.

We must, therefore, always direct our attention to these two great points in the study of cutaneous eruptions—the local condition and the general state. The general derangement may manifest itself by changes of which the skin affection is but one out of many; or the cutaneous disease may be the sole manifestation, or, at least, the chief evidence, of the general disorder. On the other hand, affections of the skin arising from local causes, or, as more frequently happens, aggravated by local influences, may give rise to a general disturbance of the whole system.

For the classification of skin eruptions the most satisfactory and the most solid system would be one based on their causation, rather than on their special forms. Hitherto this has only been possible to a slight extent, as the causes of many eruptions are unknown, and the causes of others are not uniform, or, perhaps, are complex and indirect. The real cause of eruptions must be kept in view, however, so far as this is possible. It is of the utmost importance, for example, to know whether an eruption is due to iodide of potassium, to smallpox, to syphilis, or to scabies; any system which would group together such diverse affections as "papular" or "pustular," even although they may all present papules or pustules, tends only to mislead. And further, any grouping of skin eruptions based merely on the elementary lesion is rendered impossible for any useful purpose, when we find scabies, for example, presenting at different times, or even in different parts at the same time, such diverse lesions as papules, vesicles, and pustules; or when we find eczema at one time papular, at another vesicular, at another pustular, and at another somewhat scaly; or when we find syphilis assuming nearly every variety of form.

Still, as the causes of eruptions are often unknown, and cannot even be suspected by the inexperienced, we avail ourselves of the obvious distinctions afforded by the peculiarities of the lesion; and when nothing more can be done, the student may at least describe the nature of the lesion, the extent and distribution of the eruption, and the general and local symptoms associated with it.

THE ELEMENTARY LESIONS, indeed, formed the basis on which Willan and Bateman's classification was built; and, although now discarded, like most of the old nosological systems, the facts on which it rested are of great value and are still constantly referred to; being themselves pioneers in dermatology their groupings form a guide to the beginner, and so they will be indicated here more fully than might seem proper from the standpoint of our present ideas of classification.

Erythema is a simple redness of the skin due to hyperæmia, fading readily on pressure, and not extending to the cellular tissue: there is often œdema, and in one form of disease bearing this name the lesion is deeper. (See "E. nodosum," p. 113.)

Wheals (pomphi) are well represented by the red and white elevated patches produced by the sting of a nettle, or the bite of a bug, or even of a flea; they are usually rapidly formed and quite evanescent: in slight forms the white portions may not appear; in severer forms they may be complicated with actual blisters. Their presence is usually associated with itching, burning, or tingling sensations.

Papulæ are pimples of various sizes and forms; they are circumscribed and solid, but may be very different in their constitution.

Vesiculæ and bullæ differ from each other in size, the former being small blisters and the latter large ones. They may be simple, or they may have divisions so as to be compound. They may present perfectly clear fluid under the epidermis, or they may contain inflammatory products to a variable extent, so as to present all degrees of turbidity—the separate vesicles passing through these various stages; they may be associated with all degrees of redness of the adjacent skin, or they may be free from this complication. Vesicles usually occur in clusters, the grouping and position of which are important in the diagnosis. They may pass on to suppuration, forming pustules, or their contents may dry up, forming crusts. Several vesicles may coalesce, forming large blisters or "blebs." The contents of bullæ may be sanious and slight ulcerations may be left on the separation of the crusts.

Pustulæ may result from the fluid in the vesicles becoming purulent or from the suppuration of a papule—this may arise from irritation or other inflammatory action; the pus is often formed so rapidly that it may seem to exist from the beginning. There is often an inflammatory areola at their base, and this is a point insisted on by some in their classification. When the contents dry up they form crusts or scabs. These are often of a brownish color from the admixture of blood.

Squamæ or scales and pityriasis. Scales must be distinguished from thin crusts resulting from dried secretion. Squamæ are true scales, without moisture, from the beginning. When the desquamation is very minute the term pityriasis is used. Unfortunately, however, a disease of rare occurrence, "pityriasis rubra," is so named, although characterized by the shedding of large scales or flakes.

Tubercula are little lumps, too large to be classed as pimples or differing from them in other respects. They have only an etymological connection with the tubercle recognized in the pathology of internal affections. They include various cutaneous and mucous growths of perfectly dissimilar kind.

Hemorrhages. Maculæ or stains of the skin are sometimes hemorrhagic; or they may be parasitic; chemical agents and various constitutional disorders produce pigmentary deposits. (See p. 140.)

SECONDARY CHANGES may result from or be present along with various forms of elementary lesion.

Desquamation, although often occurring independently (see "Squamæ"), may form the terminal stage of an erythema, or some inflammatory process by which the epidermis has suffered.

Crusting is one of the most important secondary changes. Very thin crusts may resemble scales, but careful examination usually shows them to be largely composed of dried secretions (in ichthyosis, however, the scales are epithelial). The discharge may be very slight, and may proceed from a surface not ulcerated, or it may proceed from an ulcer. When the crusts are dark, this usually points to the presence of a sanious fluid retained in them, and this occurs frequently in syphilis. Lupus and syphilis differ in their tendency to scabbing—the ulcers in the former usually scabbing slightly, those of the latter often scabbing freely.

Limpet-shaped crusts are almost diagnostic of syphilis (rupia). Cup-shaped crusts occur chiefly in the head, composed of the parasitic growth termed favus; they are light yellow in color, and rather brittle. (See pp. 126, 127.)

Ulcerations are secondary changes which must be examined and described in reference to their edges, etc., and any attendant constitutional disturbance, as in surgical practice.

Swelling and infiltration of the skin, the results of the inflammatory process, are very important points in the diagnosis of eczema and of erysipelas. They give, in addition to the swelling, a feeling of undue hardness and resistance to the skin.

Hardness of the skin constitutes the leading feature of scleroderma adultorum. The skin feels hard, as if bound down, and it is often cold to the touch; the comparison has been made to the touching a frozen corpse; the hardness may be pretty general or it may occur in bands. A circumscribed variety in patches of circular form and pale color, resembling disks of ivory, is described by some under the name of morphœa. The form of scleroderma in newborn infants affects the cellular tissue also. It is associated with œdema and with depression of the temperature. In myxœdema the skin feels dry and parchment-like, but the suggestion conveyed is usually that of a dropsy; it will be referred to under that section.

Excoriations, fissures, scars, and atrophic lesions are frequently very suggestive, and must be recorded. The glossy skin resulting from lesions of the nerves may be mentioned in this connection, and the disfigurations described by Alibert as keloid (or cheloid) resembling hypertrophied scars.

ELEMENTARY LESIONS IN SPECIAL DISEASES.

(WILLAN AND BATEMAN).

EXANTHEMATA: ERYTHEMA, WHEALS.—Willan and Bateman had an order named "exanthemata"—the word signifying an efflorescence: this included two of the febrile eruptions rubeola and scarlatina, and also roseola, urticaria, purpura, and erythema. The eruptions of the specific fevers are now separated from other forms of skin disease and put into a group by themselves. *Purpura* is now placed in the class of hemorrhages.

Erythema may be symptomatic of adjacent inflammation or due to mechanical or chemical irritants; but it also occurs idiopathically, and some forms occupy an intermediate position. Thus E. intertrigo is due to the fretting of folds of skin against each other, often aggravated by the decomposition or fermentation of the secretions. E. læve arises from the pressure of dropsical fluid in a part. E. gangrænosum may result from pressure, as in an ordinary bedsore, but it may likewise be caused by grave trophic lesions in the nervous system. E. fugax is usually due to digestive disorder. E. nodosum differs somewhat from other forms in presenting nodular exudations as well as redness: these are usually situated over the tibia; they are often painful and tender: they appear to be frequently manifestations of the rheumatic constitution. The name erythema as a special disease was formerly applied to many cases of the slighter forms of erysipelas. *Roseola*, or "rose rash," is now usually regarded as an erythema, from which it need not be separated.

Wheals constitute the characteristic sign of urticaria or "nettle-rash," both in its acute and chronic forms. This disease is often produced by special articles of diet in certain individuals, as shell-fish, etc. (see p. 124), or at least appears due to errors in digestion, and at times to nervous disturbance. The local irritation of parasites and exposure to the heat of furnaces may also set up this condition. "Factitious urticaria" is the name used for the variety produced in certain persons by mechanical irritation: this may be of such a character that the name firmly traced with a pointed instrument, on almost any part of the skin, comes out distinctly in wheals; these white letters may remain for many minutes. This susceptibility may be lost by the individual in the course of time.

PAPULÆ.—Willan and Bateman included under this heading strophulus, lichen, and prurigo. The term *strophulus* is now suppressed by many authorities: it is a somewhat vague term applied to eruptions occurring in infants, loosely ascribed to teething, and termed popularly "red gum," "white gum," or "hives." It is not always papular, and seems often to be connected with the sudoriparous apparatus. When not papular it should be classed with the erythemata: when papular it need not be separated from *lichen.* This disease, again, is regarded by many as a form of eczema, in which the exudation takes the form of papules, and so they prefer to name it eczema papulosum or E. lichenoides. Some who admit this, still recognize forms of lichen under the names of L. ruber and L. planus. *Prurigo* is still much disputed. A special disease described by Hebra under this name is rare in this country; but papular eruptions, with the enlarged papillæ irritated and abraded by scratching, are common enough: it is better to call this a "pruriginous eruption" to prevent confusion, and if taken in this sense such an eruption is a valuable indication of itching, past or present, and so we find it in scabies, phthiriasis, and urticaria.

VESICULÆ AND BULLÆ.—Under the former, Willan and Bateman included varicella, vaccinia, herpes, rupia, miliaria, eczema, and aphtha: under the latter, erysipelas, pemphigus, and pompholyx. Our present ideas lead us to separate the specific fevers from ordinary skin disease (see p. 130), and so *varicella* and *vaccinia* may be removed: *erysipelas* in its slight forms was spoken of as erythema: in its bad forms it was so often complicated by blisters that it came under the heading of vesiculæ: it has, however, really more affinity with the eruptive fevers (see p. 139). *Aphthæ* are now spoken of only or chiefly in connection with little blisters in the mouth and tongue (see Chapter XI., "Tongue"). *Miliary vesicles* are discussed at page 139.

Herpes consists of an eruption of small vesicles arranged in groups on an inflamed base: these run their course, and are not usually succeeded by fresh groups of vesicles: there is generally a feeling of tension and burning; occasionally neuralgic pains precede or follow the eruption. "Herpes labialis" is common in ordinary colds: it also appears in many cases of pneumonia, and in some forms of urinary irritation and disease. "Herpes præputialis" appears on the prepuce and a similar eruption may appear on the glans also. "Herpes zoster" (shingles, zona) usually girdles the trunk unilaterally, limited pretty strictly by the middle line, both before and behind, but it may affect the thigh, the face, or the arm, following very accurately the course of certain nerves. It is not infectious, and rarely occurs a second time in a patient.

Eczema is now generally made to include several forms of skin disease which were formerly separated from each other. It is an inflammatory disease with exudation and infiltration of the skin, associated with a sense of burning or itching, and it tends to the formation of crusts. In the ordinary form there are vesicles (eczema vesiculosum) exuding a clear fluid, which has the property of stiffening linen; an excoriated, red, and inflamed surface usually remains exposed; the discharge may dry very rapidly into crusts which may be so thin as to resemble scales. In some cases the moist discharge, if present at all, may almost have escaped attention, redness and scaliness of the skin being the chief features (eczema erythematosum and eczema squamosum). In other cases the plastic exudation may remain below the surface, giving rise to little papules—the lichen of older authors, but termed eczema papulosum or lichenoides by some. Or the exudation, either from obvious irritation, or from debility in the subjects, may become purulent, or the secretion of pus may be abundant from the beginning: this, which was formerly called impetigo, is now often named "eczema pustulosum," or "eczema impetiginodes." Eczema is also named from the parts affected, as "E. aurium," etc.; also from obvious secondary changes "E. fissum," or from the cause, as "E. intertrigo" from friction.

Rupia; see "Ecthyma" under the "Pustulæ," for although it may begin as a vesicle with clear fluid, the contents soon become bloody or purulent. The limpet-like crusts in this disease are diagnostic of syphilis.

Pemphigus is characterized by large blisters, or bullæ, varying from the size of a pea to that of an egg, with different degrees of inflammation at their base, and followed sometimes by ulceration. Occasionally large thin crusts or scales are formed ("P. foliaceus").

Pompholyx is now merely a synonym for pemphigus.

PUSTULÆ.—It must be remembered that vesicles readily become pustules, and so some diseases may appear to come under both headings. Willan and Bateman included under "pustulæ," variola, porrigo, impetigo, scabies, ecthyma. *Variola* being a specific febrile disease is discussed elsewhere (p. 133). *Porrigo* was a general term applied to "scald heads," where the hair was matted together with crusts and scabs, arising from inflammation set up, usually in weak subjects and especially in children, and sometimes due to or associated with the irritation of pediculi. From what has been said it will appear that this is a pustular eczema. Another form is due to the parasitic disease, favus, affecting the head (see page 127).

Impetigo is merged by many into eczema, the terms E. pustulosum, impetiginosum or impetiginodes being applied to it. Some retain the name impetigo for scattered, *separate*, pustules without much inflammation at their base. A form of this disease named I. contagiosa is interesting as being both infectious as regards others, and inoculable in new places in the patient himself. *Ecthyma* is a name applied, somewhat variously, to large pustules not aggregated together, and each one surrounded by an inflamed base. They are said to occur in debilitated subjects apart from syphilis; but when very distinct they are not unfrequently of this nature, and when they dry up they form the limpet-shell crusts of rupia. Occasionally the pustule of a so-called "ecthyma" is merely due to scabies.

Scabies is classed arbitrarily under "pustulæ;" it presents, however, likewise papular and vesicular lesions. Occasionally no distinct eruption apart from scratching can be seen, especially if the hands are often in water from the occupation of the patient. It is parasitic, and is now removed to this class. The itch insect or "acarus scabiei" is found at the end of the little furrows characteristic of this disease, and can sometimes be picked out with a needle from this situation for microscopic examination. (See Fig. 23.) These furrows are seen as small white lines, about a quarter of an inch in length at most, chiefly at the sides of the fingers near the clefts; they are usually tortuous; they are sometimes inflamed, often interrupted by dots, or by vesicles, and are very apt to be destroyed in their appearance by scratching. The presence of the insects sets up violent itching; this leads to scratching and the appearance of a "pruriginous eruption," or to the development of large pustules (so-called ecthyma), or it may be to eczema. The distribution of the eruption is very important in the diagnosis (see p. 119).

SQUAMÆ.—This class included, according to Willan and Bateman, Pityriasis, Psoriasis, Lepra, and Ichthyosis.

Pityriasis, or desquamation, occurs after erythema, febrile rashes, and various other affections of the skin, but it is not usual to speak of it under this technical name when it forms only a stage in a disease. "Pityriasis versicolor" is parasitic, and is not properly a squamous disease, although minute scales are sometimes shed. (See Fig. 31.) "Pityriasis rubra acuta" is a rare disease characterized by great redness of the skin and the shedding of large true scales, without moisture and without much infiltration of the skin.

Psoriasis and lepra (alphos) are now classed as one disease; the name "lepra" (used by some for true leprosy) was formerly applied to the patches of psoriasis, in which it spread at the circumference (psoriasis circinata) while the centre was healing; the form of a ring was thus assumed. This is a true scaly disease, without moist secretions, the scales are white and often glittering, somewhat imbricated and very adherent; they appear on dusky red patches, which are slightly elevated; all degrees of density in the arrangement of scales are found. All parts of the body may be affected; the extensor surfaces of the elbows and knees seldom escape in an abundant eruption of simple psoriasis. When it appears on the palms of the hands, or on the soles of the feet alone, it is very often syphilitic. A form of psoriasis, resembling the shape of rupia crusts, has been named "P. rupioides."

Ichthyosis. When the skin is dry, harsh, and wrinkled, with thin scales loose at their edges, the term "xeroderma" is sometimes used. When the scales are thicker, more abundant, and mingled with sebaceous matter, the name "ichthyosis" is applied. It is a chronic disease dating from childhood.

TUBERCULA.—The diseases grouped by the old writers under this heading have but little in common. They were Phyma (boil), Verruca (wart), Molloscum, Vitiligo, Acne, Sycosis, Lupus, Elephantiasis, Frambœsia.

Acne is an inflammatory disease of the sebaceous glands characterized by pimples or pustules, often arising from "comedones"—small white pimples with a central black speck. "Acne rosacea" affects the nose chiefly; there are much redness and hypertrophy of the skin with more or less acne. The cutaneous surface presents dilated vessels; although often associated with intemperance it frequently exists apart from this. *Sycosis*, as now recognized, is distinguished as parasitic or non-parasitic; the latter form affects the hair follicles, chiefly on the beard and face, giving rise to pustules, papules, and crusts. The parasitic form affects the same parts, but the mischief is due to the same kind of parasite as occurs in ringworm. (See Figs. 28–30.)

Lupus is an inflammation and ulceration of the skin occurring in scrofulous subjects, and characterized by the presence of new formation. When slight and superficial, without ulceration, it is called "lupus erythematodes." When the deposit forms little swellings, without ulceration, "lupus non exedens" is the term applied; when ulcerations and cicatrices are present, it is called "lupus exedens;"

even in the other form, however, subcutaneous cicatricial marks may be traced.

Molluscum is a term applied to soft tumors of the skin, one variety is fibrous, "fibroma molluscum;" another variety, not exceeding a pea in size, is epithelial, "molluscum epitheliale;" this latter is the contagious variety.

Elephantiasis is a name applied to two quite different diseases; elephantiasis Arabum is a chronic hypertrophic disease of the skin and subcutaneous connective tissue characterized by enlargement and deformity of the part affected, accompanied by lymphangitis, swelling, œdema, thickening, induration, pigmentation, and papillary growth; elephantiasis Græcorum (or true leprosy) is an endemic, chronic, malignant, constitutional disease, characterized by alterations in the cutaneous, nerve, and bone structures, resulting in anæsthesia, ulceration, necrosis, general atrophy, and deformity. (Duhring.) True leprosy occurs in the form of masses of infiltration and tubercles (tubercular form), in smooth patches (macular form), and in patches with anæsthesia (anæsthetic form); these forms may occur separately or in combination. ***Frambœsia*** or yaws is a disease of the West Indies characterized among other things by papules or tubercles of the skin; it need only be mentioned here. ***Vitiligo*** is an affection of the pigmentation, and will be referred to under that heading (p. 142.)

A satisfactory classification of skin diseases might be attainable if the causes were more fully known. As yet, this method is only very partially available. By it the eruptive fevers are separated from other skin affections; and, indeed, in the following table they have been removed altogether. The parasitic diseases of the skin are likewise separated from others, as they form a natural group by themselves. In the absence of the etiological method the anatomical site of the disease and the nature of the pathological process, so far as it can be known, seem to form the best basis. The table here given is from Dr. Duhring's work on *Diseases of the Skin*, third edition, Philadelphia, 1882. It is essentially Hebra's classification.

CLASS I.—ANOMALIÆ SECRETIONIS—DISORDERS OF SECRETION.

Seborrhœa, Comedo, Milium, Sebaceous Cyst . .	Sebaceous glands.
Hyperidrosis, Anidrosis, Bromidrosis, Chromidrosis, Sudamen	Sweat glands.

CLASS II.—HYPERÆMIÆ—HYPERÆMIAS.

Erythema Simplex, Erythema Intertrigo . . .	Erythematous.

CLASS III.—EXSUDATIONES—INFLAMMATIONS.

Erythema multiforme, Erythema Nodosum, Urticaria	Erythematous.
Eczema	Erythematous, vesicular, papular, squamous.
Herpes, Herpes Zoster, Herpes Iris, Miliaria	Vesicular.
Pemphigus	Bullous.
Lichen Ruber, Prurigo, Lichen Scrofulosus	Papular.
Acne, Acne Rosacea, Sycosis Non-parasitica, Impetigo, Impetigo Contagiosa, Ecthyma	Pustular.
Psoriasis, Pityriasis Rubra	Squamous.
Furunculus, Anthrax	Phlegmonous.
Dermatitis	Erythematous, vesicular, bullous, etc.

CLASS IV.—HÆMORRHAGIÆ—HEMORRHAGES.

Purpura	Corium, etc.

CLASS V.—HYPERTROPHIÆ—HYPERTROPHIES.

Lentigo, Chloasma, Nævus Pigmentosus	Pigment.
Molluscum Epitheliale, Callositas, Clavus, Cornu, Verruca, Ichthyosis, Keratosis Pilaris	Epidermis, papillæ.
Scleroderma, Morphœa, Sclerema Neonatorum, Elephantiasis Arabum, Dermatolysis	Corium.
Hypertrophy of the Hair	Hair.
Hypertrophy of the Nail	Nail.

CLASS VI.—ATROPHIÆ—ATROPHIES.

Albinism, Vitiligo, Canities	Pigment.
Atrophia Cutis, Atrophia Senilis, Striæ et Maculæ Atrophicæ	Corium.
Alopecia, Alopecia Areata, Atrophy of the Hair	Hair.
Atrophy of the Nail	Nail.

CLASS VII.—NEOPLASMATA—NEW GROWTHS.

Keloid, Molluscum Fibrosum, Xanthoma	Connective tissue.
Rhinoscleroma, Lupus Erythematosus, Lupus Vulgaris, Scrofuloderma, Lepra, Syphiloderma, Carcinoma, Sarcoma	Cellular.
Nævus Vasculosus, Telangiectasis	Bloodvessels.
Lymphangioma	Lymphatics.
Neuroma	Nerves.

Class VIII.—Neuroses—Neuroses.

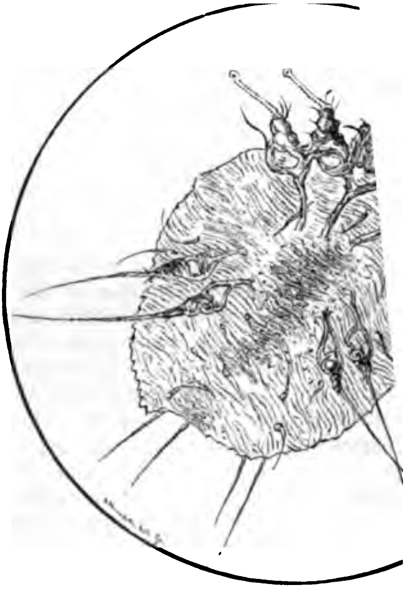
Hyperæsthesia, Dermatalgia, Pruritus	Hyperæsthesia.
Anæsthesia	Anæsthesia.

Class IX.—Parasitæ—Parasites.

Tinea Favosa	Vegetable.
Tinea Trichophytina.—T. Circinata, T. Tonsurans, T. Sycosis	
Tinea Versicolor	
Scabies, Pediculosis Capitis, Pediculosis Corporis, Pediculosis Pubis	Animal.

[Eruptive Fevers. See p. 130.]

Distribution of Eruptions.—In examining a cutaneous eruption, it is a great advantage to see the surface of the whole body, or as much of it as possible. Special abundance of the eruption on certain parts, or the special exemption of others, affords at times considerable assistance in the diagnosis. We can in this way also detect the symmetrical character of many eruptions, or the essentially local disposition of others—as when the hand or forearms are affected by some irritant encountered in a trade, or when the eruption is limited to the legs and caused by stockings with aniline or arsenical dyes. Some eruptions, again, follow the course of certain nerves, and in zona we have usually a pretty strict limitation to one-half of the body, the eruption stopping at the middle line both before and behind when the trunk is involved. But in addition to this general view of the surface, special regions must be examined for special eruptions. Of the febrile rashes, some show first on the face (variola and morbilli), but most of them appear first on the trunk, so that we must search the chest, abdomen, and back, and we should also examine the arms at the anterior aspect of the elbows, etc., where the skin is delicate. We look at the extensor surfaces of the elbows and knees particularly in psoriasis; at the chest and back in syphilis; at the clefts of the fingers in scabies, to see if any little furrows are present with acari at their extremities (see Fig. 23); and also at the inside of the thighs, the external genital organs, the mammæ, the wrists, ankles, and umbilicus in this affection; the face is almost always exempted. We examine specially the chest, armpits, and between the shoulders for phthiriasis; over the chest for pityriasis versicolor; on



The itch insect, *Acarus scabiei.* Female; ventral aspect.

The constitutional disturbance and th associated with cutaneous eruptions must into. Pyrexia, headache, and perhaps d back, sickness, vomiting, or shiverings; tingling, and itching in the parts affect portant. Intense pyrexia often precede the rash in the back and vomiting are especially suggestive of smallpox; intense headache of typhus; sore throat and vomiting of scarlatina; coryza and bronchial catarrh of measles; shiverings may occur in the early stage of any of these, and also in erysipelas. But even in those forms of eruptions, more usually called diseases of the skin, there may be much constitutional disturbance, with considerable pyrexia and some gastric disorder, as in eczema and urticaria. The intensity of the general symptoms bears a much more distinct relation to the extent of the cutaneous affection in these cases than in the eruptive fevers. Severe neuralgic pains sometimes precede, sometimes follow, the eruption of herpes zoster. Considerable pain is often experienced in eczema, but in such a case the cause is apparent.

Itching is an important fact in cutaneous disease. It is seldom very troublesome in the eruptive fevers, although often present to some extent in measles, smallpox, and chickenpox. It is seldom marked in syphilitic eruptions, so that its absence counts for something in the diagnosis. In urticaria, psoriasis, and eczema, itching is often very troublesome. In parasitic diseases it is a very prominent feature, especially in scabies and phthiriasis. The existence of itching can usually be recognized by the presence of a "pruriginous eruption" due to scratching, and the marks of the nails often tell the same story; this irritation alters the appearance of an eruption very materially, chiefly by causing inflammation. Itching, however, may exist without any eruption. In some of these cases, this may be due to a nervous affection of the skin, as in "pruritus senilis," the itchiness varying much at particular times. Pruritus, especially at the intestinal and genito-urinary orifices, may be symptomatic of pregnancy, or of disease of the womb, stone in the bladder, diabetes, piles, or other affections of the rectum. In many cases, especially (although not exclusively) in children, itching at the anus is due to the presence of thread worms; in them it is often associated with itching at the nose also, as manifested by picking at the nostrils. But this picking occurs also in diarrhœa and other forms of intestinal irritation.

Itching is occasionally present to a troublesome extent in jaundice; it is not unfrequently produced by the internal use of opium and morphia in all their forms. Some persons are especially liable to this inconvenience from the use of opium. An itching of the eyelids is one of the indications of the action of arsenic.

CAUSES OF CUTANEOUS ERUPTIONS. INFECTION, MEDICINE, FOOD.—In inquiring as to the cause of eruptions, we may ascertain the patient's ideas on the subject, or we may interrogate him as to special points in connection with special forms of disease.

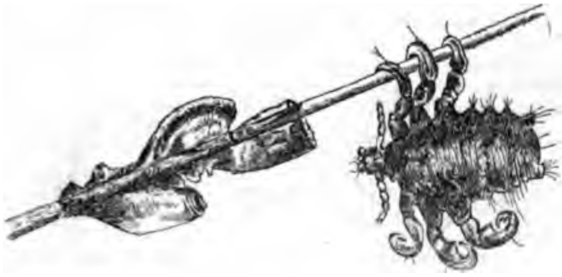
Infection.—In the group of eruptive fevers we inquire for any similar illnesses in the same family or neighborhood. Some assistance is at times obtained by learning that the patient has formerly had certain specific fevers, as a second attack in some of these is but rarely met with. (See p. 131.) In suspected erysipelas, we inquire for exposure to this disease in surgical wards, or otherwise; and for any contact with puerperal fever or pyæmia, especially if our patients are predisposed to infection by recent delivery, open sores, etc. In children, and especially in hospital practice, where infection may be present, wounds or open sores predispose to the occurrence of scarlatina, which may be mistaken for erythema or erysipelas.

In syphilitic eruptions we may inquire for the history of the original infection in the patient. Sometimes we inquire as to the husband in the case of a suspicious eruption in a married woman; of course, in doing so care and discretion must be exercised. Or in the case of congenital syphilis we may have to search for the evidence of infection in the parents, and in the brothers and sisters; in this last variety, the occurrence of abortions *before* the birth of the patient is often an important indication of syphilis. But in addition to cases of this kind, we can sometimes trace the infection of a patient from secondary or congenital syphilis. A nurse's arm may be infected from the sores on an infant's anus, or the nipple from the sores on the child's mouth, or *vice versa*. (See "Syphilitic Eruptions," p. 143.)

In impetigo contagiosa the patient may inoculate one part from another by means of scratching, or may communicate the disease to another person. The occupation is important in connection with cases of suspected glanders, malignant pustule, etc.

In parasitic diseases we often gain considerable assistance from the knowledge of their having spread by infection. Thus, if two persons sleep in the same bed, scabies in the one is almost certain to be communicated to the other. This disease is also communicated by infected bedclothes, apart from any direct contact with patients so affected. In ringworm the affection often spreads from the use of ths same hair-brushes, although the patients may not otherwise be much associated: ringworm of the body may appear in those who are attending on children whose heads are affected. In favus the contagion may be derived from some pet animal as well as from a patient. The pediculus pubis is sometimes found in persons of good position from their consorting with prostitutes. Its presence usually gives rise to great itching and irritation of the parts, but does not always do so. This parasite may affect other portions of the body as well as the pubes; it is found in the axilla, and also on the eyelashes or eyebrows, particularly in the children of the poor: the ova may be found at the roots of the hairs, presenting a definitely roundish contour on examination with a hand lens, and so distinguishable from small scabs or crusts which they closely resemble. On pulling out a few hairs they can be examined microscopically on a slide. (See Fig. 24.) The itch insects, and pediculi corporis and their ova often continue to act on the patient through the medium of the underclothing and the bedclothes, even after those on the skin have been got rid of. Indeed, the clothes of the patient are the special habitat of the pediculi referred to, which are on this account sometimes named "pediculi vestimentorum:" they often lurk in the seams, where they also deposit their ova, and so escape destruction. Certain varieties of the same parasitic disease must be borne in mind while searching for the history of infection—thus we have ringworm of the head, of the body, and of the beard.

FIG. 24.



Pediculus pubis, or crab louse, with ova adhering to the hair. (Drawn by Dr. John Wilson.)

Many cutaneous diseases have been found to be associated with and presumably due to specific microörganisms. The bacillus of tubercle and of leprosy and the microbes of the eruptive fevers, erpsipelas, and syphilis may be mentioned; but the subject is too complicated, and in some phases of it too uncertain, to demand more as yet than a mere reference to it in such a book as this.

Certain medicines and articles of diet are apt to produce cutaneous eruptions. Shell-fish, preserved salmon, cucumbers, walnuts, game, sausages, pickles, spices, even strawberries, and various other articles produce at times an eruption of urticaria or erythema. Some persons, indeed, are particularly liable to this effect from special articles, so that it is almost certain to follow their use; in others, the effect is less constant. These eruptions sometimes simulate the specific fevers; the absence of consitutional disturbance in proportion to the rash, and the absence of the special features of the specific fever simulated may sometimes guide us in the discrimination. Of medicines, iodide and bromide of potassium, belladonna and atropine, quinine, salicylic acid and its salts, chloral, sulphur, arsenic, tar, and copaiba may be named as all producing at times cutaneous eruptions; and the application of carbolic acid as a dressing sometimes determines an eruption of erythema which may simulate scarlet fever.

Iodide and bromide of potassium produce pimples (acne), which appear chiefly on the face and shoulders; occasionally the eruption is more distinctly pustular, and has even been mistaken for smallpox. The eruption is sometimes hemorrhagic. The affection of the mucous membrane of the nose and eyes, and the swelling of the glands behind the jaws, sometimes guide us in the recognition of iodism.

Belladonna and atropine produce at times a distinct erythema somewhat resembling that of scarlatina; a certain similarity to the eruption of measles is found in some cases. This rash may result from the internal use of the drug (usually in full doses), or from the action of external applications in the form of plasters, especially if excoriations exist on the skin. Dryness of the fauces and more or less dilatation of the pupils are usually present to assist in the recognition of this eruption.

Quinine sometimes gives rise to a very pronounced red efflorescence; this effect is not common, and depends on an idiosyncrasy in the patients affected.

Chloral often produces a congestion of the skin, and this may assume the character in certain cases of patches of redness like scarlatina or urticaria.

Salicylic acid and the salicylates also determine patches of erythema and blotches of ecchymosis, which are liable to be further complicated by the effects of profuse sweating

Antipyrin, thallin, and some other of the newer antipyretics, produce red rashes at times.

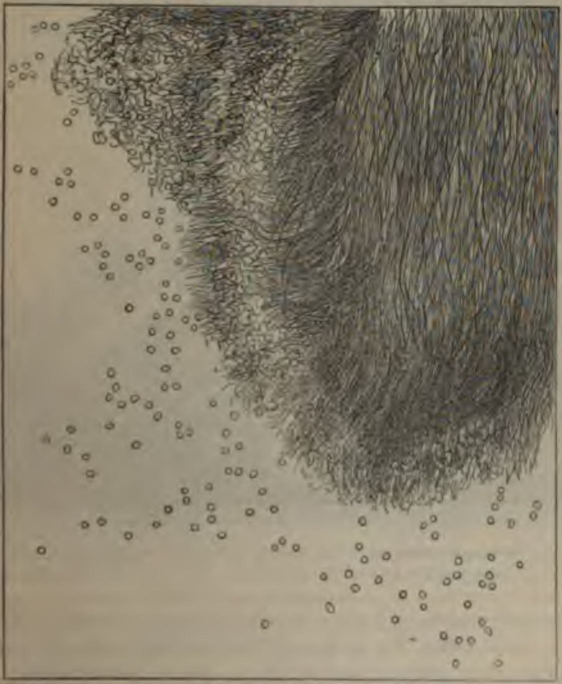
Opium also seems at times to give rise to patches of redness in the skin.

Arsenic produces, although but rarely, an eruption somewhat resembling eczema, or at least a prominence of the papillæ with congestion of the skin. In certain cases herpes zoster has appeared to be due to the use of arsenic, and pityriasis rubra has also been known to supervene in connection with its administration. Puffiness and itching of the eyelids, sickness or pains in the bowels, and whiteness of the tongue assist in the recognition of arsenical influence. Local irritation from arsenic may manifest itself by ulcerations of the part affected.

Sulphur and tar are said to produce at times an eruption resembling a badly developed eczema, and large doses of turpentine may produce an erythema.

Copaiba gives rise in some cases to urticaria of the usual kind, but

FIG. 25.



Root of hair affected with favus, showing the spores: 250 diameters. (Drawn by Dr. John Wilson.) See p. 127.

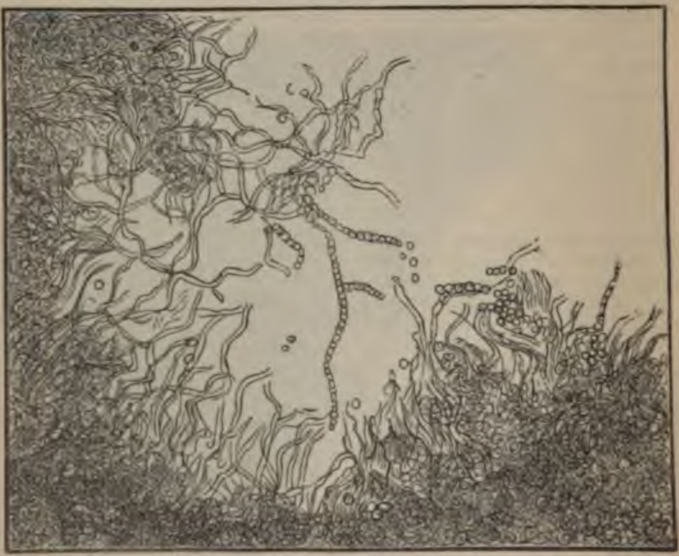
the white parts of the wheals may be absent, so that the rash is only red; at times this eruption closely simulates measles in its general appearance, but it does not specially affect the face, and is not associated with catarrh. Copaiba is so much used in the treatment of gonorrhœa that when we see an eruption associated with this disease we should always suspect the action of this drug. Cubebs has also been known to produce a similar rash.

Nitrate of silver administered internally for some time may cause a dark discoloration of the skin affecting the parts exposed to the light.

In addition to the above, a great many remedies produce eruptions from their local action if applied to the skin.

AFFECTIONS OF THE HAIR: EXAMINATION OF VEGETABLE PARASITES.—Absence of the hair is termed "alopecia." This is sometimes, although very rarely, almost universal, affecting the face and head, the pubes, eyebrows, and even the minute hairs in every part of the body (alopecia universalis). The baldness of advancing years, and premature baldness, which is often hereditary, need only be mentioned. The loss of the

FIG. 26.

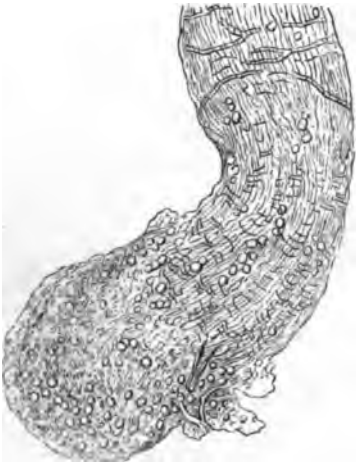


Portion of favus crust, showing the mycelium, with septate cellular tubes, moniliform rows of cells, and free spores: 250 diameters. (Drawn by Dr. John Wilson.)

hair in syphilis, and after fevers and erysipelas, is usually only temporary, but sometimes a partial baldness becomes permanent in this way. Limited patches of baldness on the scalp, and more rarely of the beard, assuming a circular form, or at least with circular margins, are termed "alopecia areata;" in this affection the hair is quite absent in the fully developed affection, the skin being quite smooth and even glossy. It is supposed by some to be due to a parasite (Microsporon Audouini), but it is regarded now by most authorities as a neurosis. In ringworm and favus the hairs are not quite absent, the bald patches present some stunted hairs. In favus the hairs are found, in a typical case, to pierce a cup-shaped yellow crust near its centre; this sulphur-colored crust frequently has a mouse-like odor; patches of red, irritable, shining skin may be found where the hair follicles have been destroyed. The parasite in favus is named *Achorion Schönleinii.*

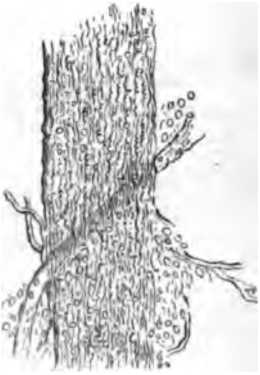
In ringworm the hairs resemble stubble, being dry and withered or sometimes half broken; the brittle hairs break off short; there is often white dust at their bases, and the skin between them presents an appearance like that of a plucked

FIG. 27.



Portion of hair from a case of favus—*Tinea favosa*—showing spores of vegetable parasitic growth—*Achoroin Schönleinii.* (Reduced from Bazin.)

FIG. 28.



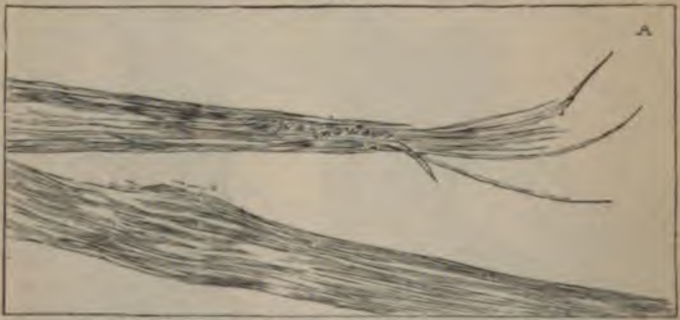
Portion of hair from a case of ringworm, showing vegetable parasitic growths (with sporules infiltrating hair, and a fragment of a tubular growth)—the *Trichophyton tonsurans.* (Reduced from Bazin.)

fowl. The parasite in ringworm is named *Tinea trichophytina* or *Tricophyton tonsurans.*

In examining hairs, scales, crusts, etc., for vegetable parasites certain precautions should be used. A diseased hair should, of course, be selected, if possible, for the examination; we judge by its stunted, brittle appearance, and by its looseness on extraction. In examining scales, too much of them may render the specimen rather opaque; the scales and even the hairs may have to be dissected by needles to expose the parasitic growths. Digestion in a solution of caustic potash renders the specimen more transparent. In certain cases it is desirable to get rid of the fat about the hair or the scales, as the small oil globules simulate vegetable spores. To remove these, sulphuric ether may be used, either before the application of the potash or after it, the specimen being dried from the one before the other is applied.

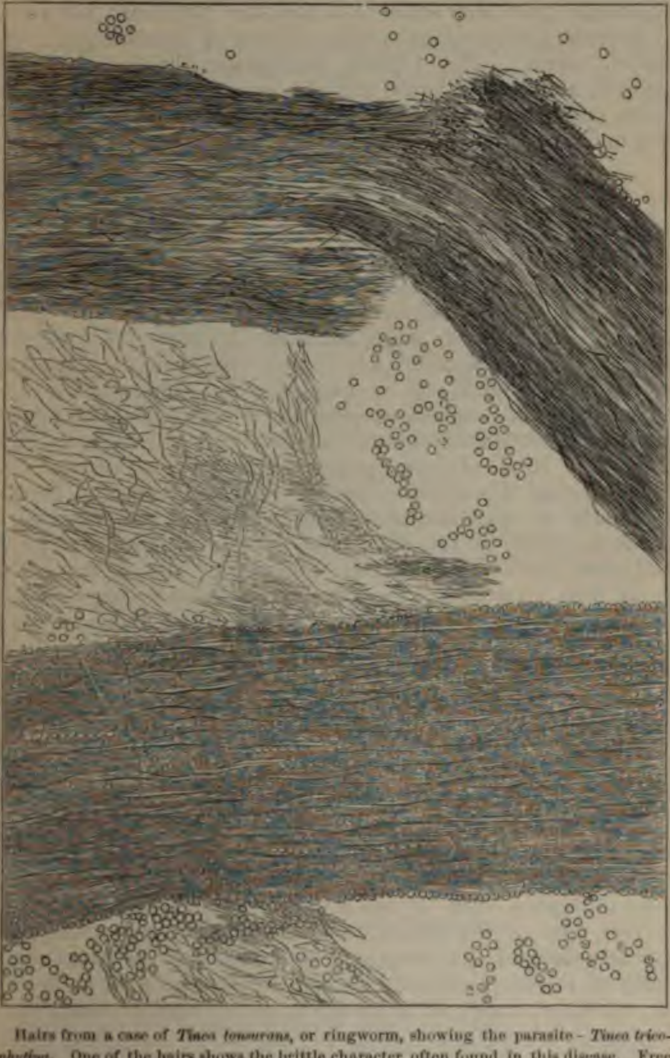
In examining for vegetable parasites, we search for spores (conidia); these are small globular bodies, usually arranged in groups or clusters, or in rows; when rows of these exist they may give off branches (sporidia). Branching tubes, often of a very fine thread-like structure, constitute the "mycelium" or "thallus" of these vegetable growths; they vary much in diameter, and often interlace in the most intricate manner. These growths are not destroyed by caustic potash, alcohol, ether, or chloroform; in doubtful cases, where fat, blood, or pus may simulate spores, these reagents may be absolutely

FIG. 29.



Downy hairs found in ringworm after treatment by blistering. The upper hair shows the point split into filaments by the action of the parasite; the lower shows the shaft split up in the same way: 250 diameters. (Drawn by Dr. John Wilson.)

FIG. 30.



Hairs from a case of *Tinea tonsurans*, or ringworm, showing the parasite - *Tinea tricophytina*. One of the hairs shows the brittle character often found in this disease. Free spores are seen lying loose as well as in the substance of the hair: 300 diameters. (Drawn by Dr. John Wilson.)

and ringworm. (See Figs. 25 t
tive notes.)

FEBRILE RASHES.

Certain specific febrile diseases are
appearance of a cutaneous eruption. The
and scarlet fever, measles, smallpox, a
sipelas may also be included in this list
pose. In addition to these, cutaneous e
and uncertain character, are *occasionall*
fever, in diphtheria, and in cerebro-spina
have alleged the occasional presence of a
monia and acute tuberculosis, but this mus
doubtful. In all of these diseases the erup
constitutional disturbance and the gener
especially by pyrexia, shiverings, sickne
headache, pain in the back, and general
and great nervous disturbance: convulsions
in children. Certain of these symptoms ar
in some fevers than in others, and severa
almost absent in a given case. In additi
may be regarded as more or less common t
toms are found in special fevers: as the s
latina and diphtheria, the bronchial cata
measles, and the diarrhœa of enteric feve
infection or the presumption of immunity
from previous attacks of special fevers so
diagnosis. The date at which the rash app
at a given time, constitutes an important e
ferential diagnosis. But in considering t
some allowance must be made for uncerta
correct date of th

fully in the remarks on the eruptions in detail, the following dates may be given:

DATE OF APPEARANCE OF THE FEBRILE RASHES AFTER THE FIRST SIGNS OF ILLNESS.

Scarlatina rash appears on the first or second day.
Smallpox appears on the third day.
Measles appears on the fourth day.
Typhus appears on the fifth day.
Enteric fever appears on the seventh day or later.

Chickenpox usually shows itself within the first day after the constitutional disturbance, but this is often so slight as not to be clearly marked.

German measles (red measles, rötheln, roseola, rosalia, etc.) may appear on the second, third, or fourth day, or the rash may be amongst the very first symptoms recognized.

Erysipelas varies considerably as to the date of its appearance on the skin, but may usually be detected on the day after shiverings or other febrile disturbances have appeared. Occasionally, however, the rash is delayed or suppressed, or appears only as fugitive patches which readily escape notice, just as happens in certain cases of scarlatina.

PERIOD OF INCUBATION.

This is not always uniform, and in many cases cannot be determined with accuracy, as the infection may linger in the clothing or other materials (fomites), for some time after the more obvious exposure of the person to the disease.

Scarlatina: incubation period varies from a few hours to eight or ten days; apparent prolongation for a longer period (which is not unusual) can often be explained more naturally on the supposition of infection through clothing and the like.
Smallpox: thirteen or fourteen days.
Varicella, or chickenpox: ten to fourteen days.
Measles: usually about a fortnight; said to be seven days when inoculated from nasal mucus; variation in extreme from seven to twenty-one days.
German measles (Rötheln): varies from seven to fourteen days.
Typhus fever: varies from a single day to nearly three weeks; usually about seven to fourteen days.
Enteric fever: about two or three weeks.
Erysipelas: period very uncertain; probably short, as a rule.

LIABILITY TO SECOND ATTACKS.

Scarlatina: an indubitable second attack very rare, but not unknown; dubious illnesses erroneously called scarlet fever may account for most of the so-called second attacks.
Varicella, or chickenpox: a second attack extremely rare.
Typhus fever: a second attack extremely rare, but not unknown; the common confusion between typhus and typhoid (enteric) fever must be remembered in judging of the history of patients.

Smallpox: a second attack by no means rare; errors in the diagnosis from other forms of pustular eruptions are quite possible. Traces of former attacks are usually visible.
Measles: a second attack, as alleged, is very common; possibly this may arise from there being two forms of measles with quite distinct powers of infection (see "Rötheln" or "German measles").
Enteric fever: one attack does not seem to afford much if any protection from a second (relapses are also very common).
Erysipelas: one attack seems rather to predispose to a second than to afford exemption.

The scarlatina rash, when well developed, presents a bright uniform redness very similar to that of a boiled lobster. In the early stage a multitude of minute red points can often be recognized, but these soon coalesce and present a uniform redness. The rash usually appears first on the chest, abdomen, neck, or back. It sometimes comes out first on the legs. It disappears on pressure—pressure with the fingers, or strokes with the nails leaving white marks. In the progress of the rash it extends from the trunk to the arms and legs, and frequently can be seen to have, as it were, fresh developments, fading in one part while extending to others, and varying in brightness at different times. Toward the end of the first week it usually begins to fade, and disappears as a rule before the tenth or twelfth day. After the rash fades desquamation begins, and this is usually in proportion to the severity of the rash. (Desquamation, arthritic pains, and albuminous urine often point to the scarlatinal nature of a rash previously regarded as trifling.) At times the scarlatina rash is so faint and evanescent as to elude recognition. Examination by good daylight is very important in such cases. In malignant forms the rash is sometimes very dusky or almost petechial; in other cases it is patchy and shifting in its appearance. In the puerperal form the rash may not be noticeable, or may only be traceable as slight patches on the hands or elsewhere.

The rashes most likely to be mistaken for scarlatina are the belladonna rash, the eruption of urticaria when the white parts of the wheals are absent, and some forms of erythema. This last disease has probably been the real affection in some patients said to have been repeatedly attacked by scarlatina. In young infants a transient erythema or roseola sometimes simulates scarlatina; its repetition and the absence of sore throat serve to distinguish it. The bright redness and the copious desquamation in "Pityriasis rubra acuta" have sometimes been mistaken for scarlet fever. In "German measles," the rash often resembles scarlatina so closely that it cannot be discriminated in the later stage of the eruption. In all cases of doubtful rash, the character of the tongue, and especially the presence of sore throat, with patches on the tonsils or ulcerations, constitute most important guides; indeed, *when the rash is copious* we must have great hesitation in admitting its scarlatinal nature if there be no sore throat. Constitutional disturbance and pyrexia are present in all degrees in scarlatina, and sometimes are so slight as to evade our recognition. Subsequent desquamation or peeling of the skin about the fingers or elsewhere, and the occurrence of albuminuria about the tenth to the twentieth day, often clear up the nature of a doubtful rash. A previous attack of scarlatina is not an absolute protection from this disease, but it is rare to find clear evidence of a second attack. There is great variety in the predisposition to take scarlet fever. A person may have been exposed to the disease, even in the same bed, and escape the infection, but may be attacked on much slighter exposure later on.

An eruption of roseola, resembling, to some extent, that of scarlatina, sometimes appears before the smallpox rash comes out. It is likewise found after vaccination, and revaccination. A similar redness is noticed occasionally in enteric fever in its early stage, and in connection with relapses. (Roseola exanthematica.)

The smallpox eruption (variola) appears as a rule on the third day, but sometimes on the second, fourth, or fifth. In serious cases it appears early, as a rule. The stage of incubation is usually a fortnight. Occasionally a "roseola" precedes the true smallpox eruption, giving rise to the idea of scarlatina. The appearance of the smallpox rash is usually associated with a distinct, and often with a very great diminution of the previous febrile disturbance (see Fig. 10), unless, indeed, in the graver forms, where the decline may be scarcely noticeable. The eruption appears first on the face and neck in most cases, but sometimes on the palate, the wrists, or the trunk; it spreads to the other parts in a day or two. At the beginning the eruption consists of red papules: these can be felt to be hard, like small shot embedded under the skin. The pimples in the course of a day or two become vesicular, but the contents rapidly become purulent, and an area of inflammation (areola) appears around the pustules; considerable swelling and itching of the skin usually accompany a severe eruption. When the pustules run into one another they are called "confluent," when they remain quite separate the term "discrete" is applied. A depression in the centre of the pustule usually becomes apparent soon after it is formed, but this "umbilication," as it is called, does not always occur, and sometimes it becomes effaced. Each pustule is multilocular. The "maturation" of the pustule occurs about the ninth day. As the pustules shrink scabs are formed, and when these separate dark colored stains remain for a time. Depressed marks or "pits" are left in proportion to the severity of the case. The smallpox papules may often be felt in the roof of the mouth, the soft palate, and the tongue; the eruption occurs, also, in other parts of the mucous surface. In severe cases hemorrhages are seen under the skin as well as inside the pustules. Hemorrhages from the mucous membranes and a few papules may be the only visible manifestation of hemorrhagic smallpox.

In smallpox modified by vaccination (varioloid), the eruption is usually less abundant and is not often confluent. The constitutional disturbance may be considerable or but slight. The eruption may closely resemble that of unmodified smallpox, or it may consist simply of a few abortive pimples without any proper vesication or pustulation. Vaccination and re-vaccination lessen the chance of contracting smallpox very materially. (For diagnosis see below.)

Chickenpox (varicella) resembles smallpox in many respects, but it is essentially vesicular, although it may be pustular where irritated; the hard nodular papules are usually absent. The eruption has no special preference for the face, but rather for the shoulders, back, and hairy scalp. The vesicles are preceded by an eruption of red spots, but slightly elevated: the lesion is altogether much more superficial than in smallpox and there are no dissepiments in the vesicles. The eruption usually appears within twenty-four hours of the preceding disturbance, if there has been any, but as a rule this is slight. A succession of separate crops of the eruption can often be recognized from their being present in different stages. It is an infectious disease, but usually attacks children only. It is not prevented by vaccination, and does not protect the patient from smallpox.

The chief difficulties in the diagnosis of smallpox arise in the slighter forms, occurring in vaccinated persons, as the few pimples which appear may be regarded as trivial, especially if the patient be subject to acne. In some forms of measles a certain resemblance to smallpox arises from the spots in the early stage being unusually hard, or from the dusky hue and hemorrhagic tendency of the rash. In some forms of smallpox also, the rash resembles measles from a transient efflorescence forming a basis for a subsequent papular eruption. The presence or absence of the shot-like papules peculiar to smallpox and the subsequent course usually guide us aright. A pustular eruption in syphilis sometimes resembles smallpox very closely, especially when it appears after great general disturbance. An eruption from iodide of potassium, usually papular but sometimes pustular, occasionally simulates smallpox. The presence of the loculi and the umbilication in smallpox pustules are often useful in guiding us.

Chickenpox, although usually differentiated easily enough from smallpox, is sometimes quite undistinguishable from the modified form of the disease, at least in isolated cases.

The measles eruption (rubeola, morbilli) appears usually on the fourth day, and corresponds with an exacerbation of the prodromal fever. (See Fig. 11.) It appears almost always on the face first. It consists of elevated red spots or patches, which tend to assume a circular or crescentic outline. At first the skin between the spots is not red, but it usually becomes so in some parts, and the elevated patches often coalesce. The eruption spreads from the face to the trunk, and from the trunk to the limbs. It may be three or four days before the rash attains its maximum extent, and it may be fading in some parts as others become affected. The rash fades on pressure in ordinary cases, but in grave forms the eruption may be dusky and even petechial. Considerable swelling of the skin of the face is usually obvious in measles. The coincident phenomena generally guide us aright in the early stage or in doubtful cases; running at the nose and eyes, sneezing, cough, and bronchitic râles are very common. In cases with a receding or undeveloped rash we have, at times, grave nervous disturbance.

The eruptions most likely to be confounded with measles are copaiba rash, typhus, roseola, and hemorrhagic smallpox in the early stage.

The German measles rash (rubeola notha, roseola, rötheln, rosalia) resembles at times measles and at times scarlatina, or it may begin with a resemblance to measles and become very like scarlatina. It does not show such a preference for the face as measles, and the crescentic character is less marked. The rash may be very abundant with but a moderate temperature (102° or 103° F.). It usually appears about the same time after the beginning of the febrile disturbance as a scarlatina rash, but may be somewhat later. There may be slight sore throat, but seldom any distinct patches or ulceration. There may be slight bronchial catarrh. The symptoms, like the rash, present a combination of the peculiarities of scarlatina and measles, but the whole disease is usually mild and of short duration, and the rash disappears in three or four days. The disease is communicated by a special infection, evidently different from that of either scarlatina or measles, and a previous attack of one or both of these diseases does not protect the patient from German measles. It is probable that this disease is often involved in the not uncommon reports of children having had measles twice. This form of eruption is sometimes confused with a copious typhus rash, as well as with scarlatina and measles. It also resembles the copaiba rash.

The typhus rash appears from the fourth to the seventh day, usually about the fifth day from the first signs of acute illness. The rash is but rarely absent in typhus fever, except in mild attacks in young patients, and its extent and depth bear a distinct relation to the severity of the case. It is, however, very apt to be overlooked by the inexperienced, owing to its delicate tint, to its brief duration in some cases, or to the absence of good daylight for the examination. Sometimes the inexperienced look too closely into the skin, and so fail to see the mottled rash, which becomes more evident when looked at from a little distance. A dirty condition of the skin, and the presence of flea-bites, also render the recognition of a typhus rash more difficult. Flea-bites, indeed, present a considerable resemblance to typhus spots in certain stages, but the central minute dark dot or bite can often be recognized; flea-bites also are generally aggregated on covered parts of the body, typhus spots are often seen on the back of the hands. Before the rash appears in a definite form there is frequently a congestion or redness of the skin, well shown on pressing with the fingers, especially over the back, the chest, and the belly. This condition is associated with suffusion of the eyes, and a dingy complexion.

There are two elements in the typhus rash, which, however, are not always both present—these are definite spots and a more general mottling. The spots, when seen *immediately* after their appearance, are usually red, perhaps slightly elevated, and they disappear on pressure. They vary in size up to about a quarter of an inch in diameter, and are irregular in their form. In a day or so they become dirty looking, and cease to disappear on pressure. Fresh spots may appear during the first two or three days of the eruption, but these are superadded to the first ones, which remain. The spots ultimately become bluish or reddish-brown in color, and distinct petechiæ or subcutaneous hemorrhages are not unfrequently developed in the typhus spots. In addition to the distinct spots just described, we usually have soon after they appear a general mottling of the skin, as if there were a "subcuticular" eruption of minute spots. This, indeed, may be the only eruption visible in certain cases, especially in the mild forms. This mottling requires a good light for its observation, and the chest and abdomen should be well bared for the examination; pressure of the fingers is useful in ascertaining the presence of this rash. The term "mulberry rash" has been used as descriptive of the general appearance of the typhus eruption. The parts on which the eruption first appears are the trunk, more especially on the front, the parts about the front of the shoulders, and sometimes even the arms and hands. The legs, and particularly the face, are less affected, but when the rash is copious the distribution may be very general. The rash persists for about a week after its appearance, fading somewhat as improvement begins, or becoming blue, dark, or petechial as death approaches, and the spots continue to be visible on the dead body if the rash has existed for some time.

A second attack of genuine typhus is very rare, but owing to the frequent confusion of enteric fever, and perhaps pneumonia, with this disease, the mere fact of a former attack being alleged cannot be much relied on, but special inquiries as to the placé in which the illness occurred, and as to its symptoms, may clear up the doubts.

The eruptions most likely to be confused with typhus by the inexperienced are those of measles, German measles, and flea-bites. A rash somewhat resembling that of typhus appears occasionally in relapsing fever. A much more common error, however, consists in overlooking the presence of the rash altogether.

The enteric fever eruption is almost never very obtrusive, and so it is seldom noticed by the public; as a rule, it requires to be carefully looked for. It appears chiefly on the trunk, and especially on the abdomen, but an examination of the back sometimes discloses the only spots visible. The eruption consists of small circular rose-colored papules (lenticular spots) not exceeding one-eighth of an inch in diameter; they are slightly but distinctly elevated; they fade, or almost disappear on gentle pressure, and they fade in this way so long as they last, differing in this respect from the typhus spots. The number of these spots in a case of enteric fever varies exceedingly; in some cases only two or three such papules can be found on a careful search of the whole body, and in others there may be twenty or thirty on the abdomen. The abundance of the eruption bears no relation to the severity of the case. Some cases present only one or two spots, although carefully examined every day, and not very unfrequently no eruption can be found at all. The spots appear in successive crops, each crop lasting about four or five days before disappearing. This feature of a succession of rose spots is most important in the diagnosis. It can be demonstrated by marking with ink all the spots visible to-day, say with a circle, those which appear to-morrow with a triangle, and those which appear next with a square; by the time these last appear, the first marks will be found empty or containing only the merest trace of a spot. This eruption seldom appears before the seventh day of the fever, but its appearance is often much later. Fresh eruptions may continue to appear until convalescence is fairly established, and they may appear during a relapse, even although none were present in the first attack.

In addition to those rose-colored lenticular spots, very delicate blue patches (taches bleuâtres) have been described in this fever as appearing on the abdomen, and an eruption of sudamina is regarded by some as very characteristic of this disease, but these last are found in various other affections. (See "Sudamina," p. 139.)

The chief sources of fallacy in connection with the eruption of enteric fever are: (1) An imperfect examination of the trunk of the body. (2) Mistaking the presence of accidental pimples for true "rose spots;" the marking and subsequent observation of these bring out their difference. (3) Typhus spots when freshly out sometimes resemble "rose spots," as they fade on pressure at this time, but become persistent after a day or two. There is no mottling between the enteric rose spots. (4) An abundant eruption of "rose spots" has sometimes been confounded with a typhus rash.

(Enteric fever is contagious, no doubt, chiefly through the intestinal excretions; it frequently affects various inmates of a house about the same time, and arises very often from bad drains or leaking soil pipes and contaminated water supply. This may operate in poisoning milk, which seems to be a very suitable vehicle for the propagation of the poison. A previous attack does not seem to afford much, if any, protection from a second. Inquiry into these matters may aid the diagnosis.)

Sudamina or miliary vesicles are minute accumulations of the secretion from the sweat ducts, arising from obstruction to their openings. They vary in size, but are seldom larger than a pin-head. They can be felt as giving a roughness to the surface and can be seen in good light as glittering points. Their contents are usually clear; occasionally there is evidence of inflammatory action in their contents being opaque and their bases inflamed. This latter condition has been separated from sudamina by some, and named "miliaria."

Sudamina are found in various diseases characterized by much sweating, and have no specific significance, although formerly they were regarded in this light. They are common in enteric fever, acute rheumatism, phthisis, and after childbirth.

Erysipelas is characterized by redness of the skin, the inflammation has a deeper seat than in erythema, and there is usually very considerable swelling and elevation of the affected part. The redness is usually pretty sharply defined by a line bounding the part affected, and it extends, as a rule, in a continuous way from one part to another. Vesication is not uncommon in erysipelas if severe, and even the deeper subcutaneous tissue may be involved in the more serious forms (phlegmonous erysipelas) which are met with in surgical practice. Erysipelas often extends from wounds or sores, especially when it arises from infection; but it may be idiopathic, and it seems at times to arise from direct exposure of the part to cold. In medical practice it is usually found attacking the head and face, causing much swelling of the loose tissues about the eyes and nose. Or it may attack a limb, or beginning in one leg it may spread up the thigh, and crossing over come down the other leg. It occurs in newly born children, spreading sometimes from an unhealthy umbilicus, but it may appear in older children also, apart from any open sore. It may attack puerperal women, who are specially liable to such infection, and in some cases of undoubted erysipelas no rash may be visible; these attacks are usually called puerperal fever. Sometimes in grave forms of erysipelas the patches of redness are irregular and fleeting, readily escaping notice. In connection with extreme dropsy of the legs, whether the skin

r is punctured, and sometimes apart from any
pelas often forms a grave complication.

G, PIGMENTATION, AND DISCOLORATION OF THE SKIN.

ous hemorrhages are recognized by their being
n pressure. When small, the words "petechiæ"
ses" are used: when large, the term "vibices"
applied. These hemorrhages are found in typhus
llpox, in purpura, in scurvy, in diseases of the
leen, and in the terminal stage of dropsy and
ting diseases. We must examine for any history
ge from the nose, gums, or bowels, in cases of
f the hemorrhagic diathesis; and we may some-
bmucous hemorrhages in the mouth. Purpura
in connection with rheumatic affections of the
suspected scurvy we inquire for a history of de-
vegetables and milk; this may readily occur in
often live on tea and bacon and bread. The
spongy gums and fetid breath, and the existence
ardness near the hemorrhagic patches, especially
sually guide us aright. In disease of the liver,
c., the spots of hemorrhage seem to be due to a
te of the blood. In typhus fever, smallpox, and

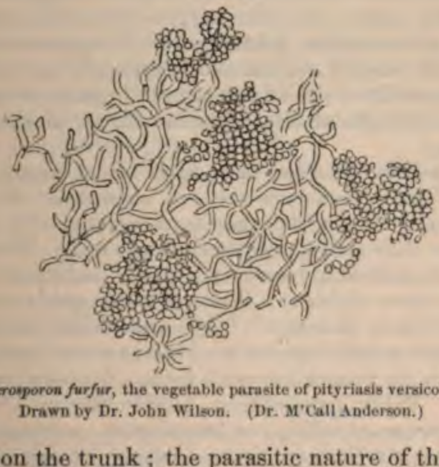
The yellow tinge of jaundice is described elsewhere, and some of the conditions most likely to be confounded with it are there referred to. (See Chapter XII.) Associated sometimes with jaundice, but also occurring independently of it, we have at times localized yellow patches, chiefly about the eyelids, but sometimes elsewhere (xanthelasma); occasionally the yellow discolorations are associated with distinct firm tumors of small size occurring in various parts (xanthoma).

Chlorosis, syphilis, malarial fevers, and cancers may all produce an unhealthy color and complexion. In phthisis, also, we sometimes see considerable pigmentation about the cheekbones, and around the orbits.

Great exposure to the air and weather, associated with uncleanliness, gives rise to a darkening of the skin with brownish spots and freckles, and sometimes a more general and uniform discoloration (vagabondismus). Sailors and others exposed to tropical climates have frequently a swarthy look, and the influence of race must not be forgotten.

In pityriasis versicolor there are defined patches of brownish discoloration, with minute scales, situated usually on the chest or at least on the trunk; the parasitic nature of this eruption can be demonstrated by scraping off a few scales, digesting in liquor potassæ, and examining by the microscope. The branching growths of the parasite and the aggregation of spores in bunches are shown in the diagram (Fig. 31).

FIG. 31.



Microsporon furfur, the vegetable parasite of pityriasis versicolor. Drawn by Dr. John Wilson. (Dr. M'Call Anderson.)

Pregnancy is very often characterized by considerable pigmentation. It is chiefly marked around the nipple, about the linea alba, and on the face. In uterine tumors, and in other forms of uterine disease, there are often distinct brownish patches on the face, chiefly on the brow, but other parts may also be affected (chloasma uterinum).

In Addison's disease, the pigmentation affects chiefly the face, the exposed part of the neck, the backs of the hands, the axillary and umbilical regions, the genitals, and the inner aspect of the thighs. This discoloration, described as "bronzed skin," resembles the tint of a mulatto, but in some parts the discoloration is darker or almost black. In many cases, considerable assistance is experienced by finding brownish stains or black streaks on the buccal mucous membrane and on the tongue and the nipples, although these also may occur in other conditions. The constitutional symptoms associated with the pigmentation in Addison's disease are those of asthenia rather than of emaciation, combined with great feebleness of the muscles, including the heart itself. Pains in the back and vomiting are not uncommon. The disease is often complicated with pulmonary phthisis, or disease of the vertebræ, but the diagnosis can be most safely arrived at when the prostration and discoloration seem otherwise inexplicable. It is commonest in young male adults; greater care is required in the diagnosis in the case of women, and especially if there be any uterine irregularity. The presence of hepatic or renal disease ought also to make us more guarded in our diagnosis in cases of bronzing.

White patches of skin may result from cicatrices of all kinds. White streaks are seen in connection with atrophic lesions of the skin, which may be associated with evidence of atrophy or defective formation elsewhere. White vertical lines on the abdominal walls are found habitually in women who have borne children; they sometimes guide us in forming an opinion as to this fact. They arise from previous distention: similar streaks are found in persons of both sexes and in children, in connection with former dropsical swellings of the belly. White patches from simple absence of pigment in the skin are named vitiligo or leucoderma: around the margin of the white patch there is an increase or deepening of the natural color of the skin. Absence of pigment in the skin, hair, and choroid constitutes albinism.

SYPHILITIC ERUPTIONS.

Syphilitic eruptions assume nearly every variety of appearance found in disease of the skin. It is of more importance to recognize an eruption as syphilitic than to define its special form.

The following points for such a discrimination are given by Dr. Tilbury Fox: 1. Previous syphilitic infection, as evidenced by the history, by cicatrices of the primary sores, etc. 2. The symmetry of syphilitic eruptions. 3. Their so-called "copper color;" dull red at first, becoming reddish yellow-brown. 4. A tendency to circular form of the patches. 5. The scales when present are very light and small. 6. The crusts are thick, greenish, or black, and adhere firmly; vesicles are flat, and do not rupture readily; ulceration is common, the surface ashy gray, and the edges sharp. 7. Pain and itching in the parts are not usually troublesome. 8. Polymorphism; papules, pustules, and tubercles coexist in the same subject, or one form of eruption gradually assumes the character of another.

As to the different periods of syphilitic eruptions he gives the following chart:

1st period—Syphilitic fever, with transient hyperæmia of the skin, giving rise to roseola, etc. (about the same time as the sore throat—a few weeks after infection).
2d period—Hyperæmia and infiltration about the sebaceous glands—syphilitic acne.
    Hyperæmia and deposit in the hair follicles, syphilitic lichen.
    —— In the derma—papular, and tubercular, squamous and pustular syphilis.
    —— About the nerves—syphilitic herpes and pemphigus.
3d period—Characterized by changes in preëxisting syphilitic formations which lead to syphilitic ulceration, exostosis, etc.

In congenital syphilis we look for mucous tubercles at the anus or mouth, red patches or pustules on the buttocks, ankles, or hands, subacute onychia, fissures at the lips; a history of "snuffles" at birth, and the presence of notched teeth or of old keratitis or nervous deafness, are important.

AFFECTIONS OF THE NAILS.

Affections of the nails sometimes serve to indicate constitutional disorders; there are also, of course, local affections of the parts.

Curving of the nails is observed along with a clubbed shape of the finger-ends, in cases of phthisis; sometimes the curving exists without any of the clubbing referred to. This deformity is not limited to phthisis, but is found in various chronic states tending to atrophy. It may be found in cardiac and aneurismal disease, and in the latter is sometimes on one side only.

Atrophy of the nails, shown by much curving, yellowish-brown discoloration, cracking, etc., may result from lesions of the nerves, or from disease of the spinal cord, and are found at times even in hemiplegia. Cases are reported of shedding of the toe-nails repeatedly in locomotor ataxy.

Transverse white marks, or thinned portions in the nails, are sometimes clearly seen after serious illnesses, such as fevers, and we may occasionally avail ourselves of them in checking the history or the dates supplied by a patient. A mark of this kind half way up the nail may be reckoned as indicating an illness three or four months previously.

The nails are sometimes shed in pityriasis rubra, and in severe eczema affecting their neighborhood. In psoriasis and pityriasis rubra, the nails are often affected, becoming dingy, thickened, curved, grooved, and dirty looking.

Onychia, inflammation of the matrix of the nail with suppuration beneath it, and loosening of its attachments, is occasionally due to syphilitic disease. Strumous disease may also determine inflammation of the nails. Parasitic diseases sometimes affect the nails (favus and ringworm).

GLANDULAR AFFECTIONS.

Affections of the lymphatic glands afford many indications of general constitutional states. They are often, however, merely dependent on *local irritation*. Thus a sore on the foot or leg, perhaps of a trivial nature, may by the strain of walking give rise to enlargement and tenderness in the femoral glands; the anatomical relationship of the lymphatics serves to indicate the connection of these with the leg, instead of the genital organs as might at first be supposed. In the neck, also, the *posterior* cervical glands may be enlarged from the irritation of an eczema of the scalp, past or present, and not as the result of constitutional syphilis. A chain of small hard glands in this situation, however, constitutes an important indication of *constitutional syphilis*, in the absence of any superficial cause for their enlargement. The inguinal glands are often enlarged, and sometimes proceed to suppuration, from the irritation of a gonorrhœa, or of a soft chancre on the penis; indeed, the history of suppurating buboes and the presence of cicatrices in the groin are to be regarded as evidence of some local irritation in the genital organs, rather than a proof of constitutional syphilis; this may, however, coexist with the other. The typical form of glandular enlargement in the groin due to constitutional syphilis, consists rather in the presence of a group of moderately enlarged, painless, and movable or rolling glands, which proceed to suppuration only in exceptional cases.

Enlargement of the glands elsewhere may be due to syphilis in the exceptional case of a primary sore being contracted in some unusual situation; a general affection of the whole glandular system is also found at times in constitutional syphilis.

Enlargement of the glands serves as a valuable indication of an affection of the system in certain forms of *cancer or epithelioma;* malignant tumors of the breast affect the axillary glands, malignant growths in the throat affect the cervical glands, and so on. Even deep-seated diseases may reveal themselves by such glandular affections, as in the case of malignant growths at the base of the skull involving the glands in the neck, and cancer of the abdominal organs affecting some part of the lymphatic system within our reach.

Enlargement of the anterior cervical glands is due in the immense majority of cases to a *scrofulous tendency* in the patient, and their presence, or the evidences of their former existence, from the scars and cicatrices left, frequently serve to indicate this constitutional taint. They may, however, be due to some of the other causes referred to in this section. These scrofulous glands sometimes remain chronically enlarged, although free from pain. In persons of a weak constitution, the lymphatic glands are sometimes enlarged from exposure to cold and other comparatively slight causes which would not affect a robust person. Scrofulous glands may occasionally be felt through the abdominal walls in cases of tabes mesenterica, but owing to the swelling and tension of the belly so frequently present in such cases, very often we cannot detect glandular swellings, even of large size.

A generalized enlargement of the lymphatic glands is so often associated with *Leukæmia*, that it is well to examine the blood microscopically when they are thus affected. The relative proportion of white blood corpuscles to the red corpuscles varies greatly even in health, and it is often considerably increased in anæmia and also in cancerous affections, but when the proportion, as estimated carefully in various fields of the microscope, amounts to 1 in 20 or 1 in 10, the case may be regarded as one of leukæmia; the proportion is often higher, and the white corpuscles may even equal the red in number. ("See Examination of the Blood," Chapter IX.) In such cases we must see if there is any enlargement of the spleen. Leukæmia may exist with enlargement of the lymphatics alone (lymphatic leukæmia), or with enlargement of the spleen alone (splenic leukæmia), or both forms of enlargement may be present. General enlargement of the lymphatic glands may exist without leukæmia, although dependent on some grave constitutional affection; the name "Hodgkin's disease" is sometimes applied to this special variety, although it is applied by others in a more general sense to cases of various kinds with lymphatic enlargements (lymphadenoma). In such cases there is sometimes a complication from the presence of a mediastinal or abdominal tumor (lymphoma) of a similar nature; these may give rise to exudations, and so the case may be mistaken for a pleurisy or peritonitis occurring in a scrofulous subject.

Enlargement of the cervical glands is of habitual occurrence in *scarlet fever;* it sometimes appears very early in the disease, before the other symptoms have been developed, but usually comes on about the second or third day of the illness, or even later. It is specially marked in the grave forms with serious affection of the throat; in young children, the enlarged glands may appear like a collar surrounding the neck, this is always a very serious indication. Glandular affections in connection with ulceration of the throat, appearing late in the course of the fever, are always of special gravity. In scarlatina, these glands often suppurate and lead to extensive sloughing.

Glandular enlargements in the neck, especially about the angle of the jaw, are sometimes found in *diphtheria* and other forms of sore throat and tonsillitis, but they seldom attain the size or extent common in scarlet fever.

Parotitis.—Inflammation and suppuration of the parotid may be due to scarlet fever, from the general invasion of the glands in this region. Parotitis is a sequela of typhus which is not uncommon. It is but rarely seen in relapsing and other fevers or in erysipelas.

Parotitis may also occur as a special affection, due to some specific infection (mumps). It is very liable to spread in schools; the period of incubation is about a fortnight. This disease attacks children chiefly, but not exclusively, and especially between five and fifteen years of age. Sometimes it is unilateral but usually double. There is considerable pain, especially on moving the jaws, and a certain amount of fever and constitutional disturbance is common. This form of parotitis seldom proceeds to suppuration, but it sometimes sets up a purulent otitis. Occasionally affections of the breast or testicle, by metastasis, have been observed.

An affection of the parotid, differing from mumps, associated with marked swelling and even suppuration, may depend on the implication of the lymphatic glands in its vicinity rather than on inflammation of the parotid itself.

The *salivary glands* when much swollen or affected with calculi usually come under the notice of surgeons.

Plague, Glanders, etc.—Acute glandular swelling (buboes) in the axilla, groin, and neck are found as a rule in the plague, associated often with carbuncles and other evidence of serious disturbance, but this disease is not now prevalent in Europe.

Glandular swellings are likewise found in connection with glanders and farcy, occurring in men infected from horses, asses, and mules; sometimes pustular eruptions and discharges from the nose likewise appear.

The Joints.

The joints should be examined in all cases in which they seem painful. When, from the presence of fever or any other cause, we suspect the existence of acute rheumatism, gout, or pyæmia, we must make a careful search in the joints for any swelling or tenderness. In syphilis, also, the history of pain in the joints is often important. The presence of chronic disease of the joints, or the evidence of past mischief in them, may often throw light on the scrofulous, rheumatic, or gouty tendencies of a patient; the evidence of old disease in the joints, or former suppuration, may serve to explain the existence of lardaceous disease of the viscera. Local disease of the joints comes for the most part under the care of the surgeon; the discrimination of the various lesions from one another, and from hysterical affections, which occasionally assume this form, must be sought in surgical works.

On the border-line between medicine and surgery is the form of disease popularly called "*rheumatic gout,*" but more correctly named "*rheumatoid arthritis,*" or "*chronic rheumatic arthritis;*" this is characterized by more or less pain, but especially by enlargement of the ends of the bones, and deformity or "nodosity of the joints;" the parts involved are often twisted out of their position. The knuckles are perhaps the parts most frequently involved in the early stage, but all the joints of the limbs, and even the articulations of the jaw, may be more or less affected. A certain crackling sensation is often experienced by placing one hand over the joints while moving or manipulating them with the other. Although essentially a chronic disease, the patient may have acute or subacute attacks superadded; we then find redness, swelling with effusion, and tenderness; in some cases there may be a considerable resemblance to gout. Enlargement of the ends of the bones always implies an old-standing affection; osseous deposits may likewise exist in the adjoining ligamentous tissues, and may even be found lying loose in the joints. The general health is usually deteriorated, and the articular mischief often dates from some debilitating or exhausting illness.

Enlargement of the ends of the bones, and other osseous growths and deformities resulting from spontaneous fractures, are met with occasionally in cases of locomotor ataxy; or the cartilages may become eroded, giving rise to crackling sounds on manipulation, and even to spontaneous dislocation; the large joints are those chiefly affected in this disease. Chalky deposits in the joints sometimes simulate the deformity of rheumatoid arthritis, and some doubt may remain in certain cases till the deposits are exposed by ulceration. Enlargement of the ends of the bones, with the appearance of "double joints," occurs in children as one of the characteristics of rickets. (See "Bones.")

In *acute articular rheumatism* (rheumatic fever) pain in the joints is usually an early symptom, although there may be high fever for a day or two before this becomes pronounced. When the pains are present in various joints we can seldom mistake the nature of the illness. But when the joints of the spine seem the only parts affected, we may indeed be in doubt, as pain of this kind often arises from serious disease of the bones, or from certain affections of the spinal cord, or of its membranes. For this reason any case of rheumatism, with acute symptoms, involving the back chiefly, without any swelling of the joints in the limbs, must always be scrutinized carefully during its progress, as many mistakes arise from applying the name "rheumatism" to such an illness; pain in the limbs, with great tenderness on handling them, may be present in the spinal affections referred to, and this tends further to simulate rheumatism; more rarely, cerebral meningitis may be characterized by hyperæsthesia in this way, and cerebro-spinal meningitis usually presents this symptom. When the patient is known to have had articular rheumatism, the case is so far simplified; a rheumatic attack may be confined chiefly to the back, but it usually involves other joints also during some part of its course.

Acute rheumatism usually produces very marked swelling, with considerable effusion into the joints, and along with this there is often redness of the skin, and almost always great pain, especially on disturbing their position in any way, so that the patient becomes very helpless, and dreads the least shaking of his bed. The mischief in the joints appears very suddenly; it is sometimes very fleeting, shifting about from one limb or one set of joints to another, or from one side of the body to the other. Relapses are very common in this disease, and one attack seems to predispose to another. We inquire in cases of this kind for the history of any previous attacks, of any exposure to cold and wet, and also for any hereditary tendency to rheumatism. We must always make a careful search for the evidence of cardiac mischief, this may exist apart from any thoracic symptoms; there is, however, usually more or less pain in the chest when pericarditis is present. The temperature of the patient is a very important symptom in rheumatism; a strict watch must be kept on it if it seems to be rising very high. With such elevations we may have alarming delirium, coma, or other cerebral symptoms, although the articular pains may be but slight or may even have greatly diminished. Sweating is habitual in acute rheumatism, and the urine is usually high-colored and loaded with urates.

In children, the joint affection in rheumatism is often so slight and fleeting, that the disease is apt to be overlooked, or attributed to "growing pains." In such cases swelling and pain about the feet are often the most marked features: in older subjects pains in the heels, of an obscure but severe character, seem often to be essentially rheumatic in nature. These slight attacks in children may be complicated with endocarditis or pericarditis, and may lay the foundation of permanent cardiac disease.

Chronic forms of rheumatism are found in elderly people, apart, it may be, from any previous acute attacks. This affection is characterized by pain and stiffness of the joints, and the muscles and tendinous structures are also more or less involved. In other cases we have the complication of rheumatic arthritis.

Quasi-rheumatic affections of the joints occur in scarlatina and relapsing fever. In the former the articular affection occurs usually after the first violence of the fever is over, and often coincides with the period of albuminuria and cutaneous desquamation. There is not usually much swelling in the joints, but the pain is sometimes very considerable. (For more serious articular affections in scarlatina, see "Pyæmic affections of the joints," p. 152.)

In relapsing fever, pains in the joints occur at the beginning of the febrile attack, and often add materially to the general suffering. They may also return with the relapse. The presence of high fever and of articular pains in this disease simulates acute rheumatism very closely, but the epidemic character of relapsing fever, and its complete absence for years together in this country, prevent any very frequent errors in this respect. Here, also, the joints are but little swollen as compared with the usual form of rheumatism. Arthritic pains and swelling occur in connection with purpura (see p. 153), and also with the hemorrhagic diathesis (see Chapter IX., "Hemorrhages").

Gonorrhœal rheumatism (gonorrhœal synovitis) is comparatively a rare affection. It must not be supposed to include all the cases of chronic articular pains in patients who have had at some time a gonorrhœal discharge. Gonorrhœal rheumatism arises during the period of the urethral discharge. It is rare, but not unknown, in the female sex. It usually attacks the knee-joint, but it may involve various joints in succession, and even the synovial sheaths of the tendons. Its appearance may be marked by a diminution in the discharge. It tends to recur with a subsequent gonorrhœal infection, or even with other forms of urethral irritation, or it may linger as a more chronic affection associated with a gleety discharge, or even after this has disappeared; recurring disease is apt to lead to serious destruction, or to stiffness of the joint; although the health suffers seriously, the patients seldom die of the disease. Occasionally this gonorrhœal rheumatism is associated with ophthalmia at its commencement, and with iritis in its later stages. As a rare occurrence we may have true pyæmic synovitis from gonorrhœa, with its usual gravity.

Gout manifests itself by pain and swelling in the joints, associated with more or less general disturbance; and it appears both in acute and chronic forms. Gout has a special tendency to affect the ball of the great toe, especially in the first attack, but almost any joint may be involved; previous injury renders a joint particularly liable to the gouty inflammation, and this may determine the site of the seizure. The joint becomes exceedingly painful in an acute attack, especially if it be the first; there are usually great swelling, redness or lividity, and tension; the veins are usually much swollen, and after the tension subsides, œdema of the part remains, and the skin desquamates. The paroxysms of pain have a marked tendency to nocturnal exacerbations. The fever is usually much less than in rheumatism, and its intensity seems more distinctly related to the local inflammation. General disturbance, and especially gastric disorder, characterized by acidity, may be regarded as usual, and cramps in the muscles are not uncommon. Alarming symptoms referable to the stomach, heart, or nervous system sometimes occur in connection with gouty attacks, or with a recession of the articular affection. The fleeting and erratic forms of attack common in rheumatism are not found in gout.

The personal and family history are very important in the diagnosis of gout in doubtful cases. Gout is rare in Scotland, except among the upper classes, although not uncommon amongst workingmen and hospital patients in London. It is more common in men than in women, and seldom appears till the patient is about forty years of age. The influence of heredity is very strongly marked, and this may determine an attack in those who are very careful in their living. The habits of the patient as to excess in eating and drinking are, however, very important; the use of malt liquors and wines predisposes to gout much more strongly than even a free use of spirits. Excess in the use of animal food is likewise potent in producing gout. The connection of lead-poisoning with gout seems also to be so frequent, in London at least, as to assist in the diagnosis. The occurrence of renal affections in gout is likewise common, and should be inquired into, and the state of the heart and arteries should likewise be investigated.

The test of the gouty condition by finding crystals of uric acid in the serum of the blood is important. Dr. Garrod recommends two drachms of the serum of the blood to be placed in a flat glass dish and set aside to evaporate slowly; it is first acidulated slightly with acetic acid, and a fine linen fibre is introduced into it; when the fluid has been reduced to the consistency of a jelly, this fibre is found crusted over with crystals of uric acid if the blood be derived from gouty patients, but there are no crystals from the blood of those free from this taint.

Chronic forms of gout become developed from repetitions of the acute affection. In gout the tendency is for the recurrences to be more and more frequent, with less distinct causes for each attack. The joints are also apt to become permanently changed, particularly from the deposit of chalky masses in their structures. These are called "chalk-stones" (or tophi—*i. e.*, concretions); they consist chiefly of urate of soda along with animal matter; their composition may be determined as in the case of urinary calculi. Sometimes these concretions give rise to small abscesses, and in this way become exposed. They are found in various joints. Before they become visible the diagnosis of these hard masses in the joints may be doubtful, as they may simulate some enlargement of the ends of the bones. Assistance is afforded at times by finding similar small concretions in the ear, especially in the helix, varying in appearance from the minutest possible vesicle beneath the skin to a bead-like nodule resembling a pearl.

The constitutional symptoms in chronic gout vary considerably; dyspeptic disorders form the leading feature in such cases.

Pyæmic affections of the joints occur in many cases of pyæmia as they arise in surgical practice. With these we have no concern here. Affections of this kind occur after childbirth, sometimes at a considerable time after delivery, associated it may be with evidence of suppuration elsewhere (*pelvic abscess, phlebitis, pyæmia, etc.*). Essentially the same kind of articular mischief occurs also sometimes in scarlatina. This puerperal and scarlatinal form of pyæmic arthritis is limited to one joint in some cases, but in others various joints are affected. Such illnesses, although always serious, are not necessarily fatal. Pyæmic disease of the joints sometimes occurs also after certain forms of pneumonia, with typhoid symptoms, and after enteric and some other fevers. When suppuration is known to be going on in a case, we must always regard articular pains with great suspicion; gonorrhœa has been known to give rise to true pyæmia, and gonorrhœal rheumatism is regarded by some as a mild form of this disease.

Pyæmia, with affection of the joints, sometimes occurs in an idiopathic form, as it may be called—that is, without any obvious cause. In such cases the symptoms may resemble those of enteric fever, although shiverings are usually present in a more pronounced form. In obscure cases it is well to examine the various joints as to swelling, redness, and tenderness to pressure.

Pyæmic joints are usually painful, but sometimes the pain is not well marked; tenderness is very generally present even in such cases. The pyæmic affection has but little of the fleeting or shifting character of acute rheumatism, but we may see, even in fatal cases, the implications of certain joints followed by their recovery, and it may be the supervention of mischief in others. Actual pointing of a pyæmic joint may take place.

Articular pains with subcutaneous hemorrhages occur both in purpura and scurvy. There is a disease, "peliosis or purpura rheumatica," in which fresh developments of articular pains and of hemorrhagic spots appear together, and there may be hemorrhages elsewhere as well; it is regarded by some as a mere coincidence of purpura with a rheumatic attack. In scurvy the articular pains and stiffness of joints, due to the fibrinous effusions found in this disease, are often so permanent as to lead to the idea of rheumatic instead of scorbutic disease. Affections of the joints are also found in the hemorrhagic diathesis. (See Chapter IX., "Hemorrhages.")

Syphilitic affections of the joints occur in a slight form in what is termed the secondary stage. But the more severe and persistent pains occur later, among the tertiary symptoms, when nodes, etc., become developed. These pains usually affect several joints, and especially involve the larger ones; they have a very marked tendency to nocturnal exacerbations, and the pains are often evidently present in the bones as well as the joints. Other evidences of syphilis usually coexist with these pains when they are severe. This manifestation of syphilis has some value in judging of the history of a doubtful case.

BONES.

Affections of the bones come so much more under the notice of surgeons that we must refer to surgical treatises for information on this subject; only a few points of special importance to the physician claim attention here.

Congenital malformations of the skull and spinal column (encephalocele and spina bifida), with protrusion of the brain and spinal cord, or of the membranes, are often important as furnishing the explanation of convulsive or paralytic symptoms.

Affections of the skull are met with in rickets, hydrocephalus, and syphilis whether this is congenital or acquired. The enlarged head of rickets may be mistaken for the slighter forms of hydrocephalus; the head, however, has more of a square shape in rickets, more of a globular form in hydrocephalus; the top of the head is usually flatter in rickets; and although the sutures and fontanelles are often unduly wide in both, we can sometimes trace the thickened edges of the rickety bones forming distinct ridges where the sutures are. In both diseases the small face often contrasts with the enlarged head, but this is usually more striking in hydrocephalus; in this disease also the eyes appear strikingly prominent from the balls being directed downward, and from the exposure of a large portion of the upper part of the white sclerotic.

Great thinning of the bones of the skull (craniotabes) is found as an early symptom in rickets and also in congenital syphilis. By searching with the finger over the occipital and adjoining portion of the parietal bone, in particular, little patches about the size of the point of the finger may be detected so soft and thin as to feel like membrane. On the other hand, thickenings of the bone may be encountered in congenital syphilis, when it involves the skull, so that four bony eminences may surround the fontanelle. (Parrot.) Syphilitic affections of the skull in the adult, with nodes or with suppuration and necrosis (corona veneris), are well known to surgeons; they may likewise point the physician to mischief within the cranium, giving rise to nervous lesions.

Old depressions or painful cicatrices have to be searched for and considered in certain cases of epilepsy.

The examination of the head by auscultation and percussion will be mentioned in the study of nervous symptoms in Chapter VI.

Periostitis, Necrosis, Ostitis, Caries.—These are usually regarded as purely surgical, but they may have many close relationships with internal disease. Syphilitic periostitis and nodes affecting the skull have been already alluded to, but it is often important to search on the tibia for evidence of old lesions of this class in suspected syphilis. Present or past periostitis, necrosis, and caries may throw light on the constitutional tendency of the patient, or of his relatives, and may point to certain pulmonary or cerebral disorders being in all probability tubercular; or such affections may give the clew to the diagnosis of lardaceous disease of the kidney, liver, spleen, and intestines. All such affections of the bones are usually so obvious, and are almost always attended with so much pain, that they can scarcely be overlooked. Occasionally, however, in young subjects, acute periostitis and "necrosial fever" may simulate a general disorder, and may be readily mistaken for typhoid or some other fever, at least for a time; the diagnosis may become further complicated by its giving rise to pyæmic pericarditis, pleurisy, etc. In connection with periostitis it may here be stated that necrosis sometimes occurs as a sequela of enteric fever. Deep-seated pains in the bones, with marked nocturnal exacerbations, may afford indications of syphilitic disease.

Enlargement of the epiphyseal extremities of the bones is a notable symptom in rickets; it occurs chiefly in the wrists and ankles, but it shows itself also in "beading" at the junction of the ribs with the costal cartilages ("rachitic rosary"). These rickety enlargements may sometimes be confused with the swellings due to congenital syphilis found at the epiphyses also; but while both are affections of infancy, the syphilitic lesion is common under six months, while rickety changes in the bones are seldom pronounced till some months later. In syphilitic affections involving the arms the child may appear to be paralyzed from this cause, and this "pseudo-paralysis" may assist the differential diagnosis. These deposits may suppurate but they seldom open into the joints. Although the ends of the bones are the common sites of the syphilitic lesion, they sometimes lead to local enlargements in the shafts, and when they involve the phalanges we have the variety termed "dactylitis syphilitica."

In the form of disease termed "acute rickets" the enlargements are very rapidly developed, and present more pain than the mere tenderness of ordinary rickets. This form of disease has been shown by Dr. Barlow to depend on acute hemorrhagic lesions due to scurvy or to some tendency allied thereto. It may coexist with true rickets, but it may occur without any manifestation of this disease.

Enlargement of the ends of the bones due to rheumatism has been discussed under "Joints." (See p. 147.)

Distortion of the long bones is found to a notable extent in rickets. In the ribs it leads to the occurrence of various forms of "pigeon breast;" this deformity will be referred to and its meaning discussed in Chapter XVI. In the lower limbs it is seldom present to any striking extent, unless the child has begun to walk, or at least to stand, and so the worst cases of rickets, early developed, do not show much deformity of the legs. The distortion resulting is best understood if we imagine all the natural curves and twists of the long bones intensified to a greater or less degree; sometimes this is enormous; but the bones may be twisted, from accidental causes, in quite different directions from the normal curves. The bones of the upper extremity are also often distinctly curved, particularly in those patients who have been too badly affected with rickets to allow of their standing or attempting to walk. In such cases the little patient sitting in bed, and moving himself from side to side with his arms, produces a curving of the bones there from the weight of his body falling upon them instead of on the legs. The clavicles are often so sharply bent as to suggest the idea of a fracture. Softening of the bones in adults (mollities ossium) is chiefly of importance from its distorting the spine and pelvis of women during the childbearing period. It is associated with obscure pains, and from the distortion the woman's stature may be diminished to the extent of two or three inches. Although much commoner in women it occasionally affects men, and the ribs and sternum may be implicated as well as the bones of the limbs, pelvis, and spine.

Distortions of the spine must be studied as to whether they are permanent, or whether they disappear on taking the weight off the vertebral column. We also ascertain whether they are lateral (skoliosis); angular, with projection backward of the spinous processes (kyphosis); or if there is a general bulging backward of the dorsal and lumbar regions, with slight projection forward of the cervical portion, such as arises from general weakness or softness of the bones, as in rickets; or if there is a "saddleback" appearance, with projection forward of the lumbar and lower dorsal region, and backward of the upper dorsal and cervical portion of the spine. The lateral distortion is found chiefly in girls of poor physique; but such deformities, even when extreme, do not give rise to paralysis. Lateral curvatures also result from pleurisy with retraction of one side of the chest, especially when this occurs in childhood; and any inequality in the lower limbs, or arrest in growth, such as occurs in infantile paralysis, tends to produce this deformity. Angular curvature is found in caries of the vertebræ (Pott's disease), and is often associated with abscess in various parts, with severe neuralgic pains, and with paralysis. The deformity named lordosis or "saddleback," occurs at times as an independent affection, but is chiefly interesting to physicians as one of the leading peculiarities of pseudo-hypertrophic muscular paralysis.

With regard to skin diseases the following works may be consulted: Hebra and Kaposi, On Diseases of the Skin, translated for the New Sydenham Society, 5 vols., London, 1866–80.—Sir Erasmus Wilson, Lectures on Dermatology, 4 vols., London, 1871–78.—M'Call Anderson, On the Treatment of Skin Diseases, with an Analysis of 11,000 Consecutive Cases, London, 1872; also his treatise on special skin diseases.—Neumann, Text-book of Skin Diseases, translated by Dr. Pullar, London, 1871.—Tilbury Fox, Skin Diseases, 3d edition, London, 1873.—Duhring, Practical Treatise on Diseases of the Skin, 3d edition, Philadelphia, 1882.—V. Ziemssen, Handbook of Diseases of the Skin, by various contributors, New York, 1885.

For illustrations of skin disease, see Sir Erasmus Wilson, Portraits of Diseases of the Skin, London, 1848–55.—Hebra and Elfinger, Atlas der Hautkrankheiten, Wien, 1856–76.—Atlas of Portraits of Diseases of the Skin, New Sydenham Society, London, 1861–84.—Tilbury Fox, Atlas of Skin Diseases (based on Willan and Bateman's Delineations), London, 1877.

For febrile eruptions—Murchison, Treatise on the Continued Fevers, 3d edition, London, 1884; this contains colored illustrations of the eruptions in typhus and enteric fevers.—Murchison, "Observations on the Period of Incubation of Scarlet Fever and some other diseases" (Trans. Clinical Society, vol. xi.), London, 1878.—Reynolds's System of Medicine, vol. i., London, 1866; and other systematic works on medicine.—Treatises on diseases of children also contain much that is important here, such as West, Lectures on the Diseases of Infancy and Childhood, 7th edition, London, 1884.—Eustace Smith, Practical Treatise on Diseases of Children, London, 1884.

The nails and hair are discussed in works on skin diseases.

The glandular diseases are treated of in surgical works; also in works on medicine in connection with leukæmia, Hodgkin's disease, etc.; *e. g.*, Gowers, "Splenic Leucocythæmia, and Hodgkin's Disease," in Reynolds's System of Medicine, vol. v., London, 1879.—Hodgkin's paper appeared in Med. Chir. Trans., vol. xvii., London, 1832.—Bennett, Leucocythæmia, Edinburgh, 1852.

For joint affections—Garrod, on "Gout, Rheumatic Arthritis, and Rheumatism," in Reynolds's System, vol. i.—R. Adams, Treatise on Rheumatic Gout, with Atlas, 2d edition, London, 1873.—For joint affection in ataxy, see Charcot, Lectures on Diseases of the Nervous System, translated for New Sydenham Society, 2 vols., London, 1877-81.—Transactions of Clinical Society, vol. xviii., London, 1885.

For diseases of bones, surgical works must be consulted, or special treatises, such as Macnamara, Clinical Lectures on Diseases of Bone,

London, 1878.—See also articles on rickets and syphilis in works on diseases of childhood, especially Roger, Recherches Cliniques sur les Maladies de l'Enfance, tome ii. (Syphilis), Paris, 1883.—Parrot (and others), Transactions of the International Medical Congress, vol. iv. p. 35, London, 1881.—Taylor (R. W.), Syphilitic Lesions of the Osseous System in Infants and Young Children, New York, 1875.—Barlow, "Cases of Acute Rickets," Med. Chir. Trans., vol. lxvi., London, 1883.—Lees and Barlow, "Relationship of Craniotabes to Rickets and Congenital Syphilis," Pathol. Trans., vol. xxxii., London, 1881.

CHAPTER V.

EXAMINATION OF THE ORGANS OF SPECIAL SENSE: TESTING OF CRANIAL NERVES.

An examination of the organs of special sense is often called for in the study of nervous symptoms. The investigation here, as elsewhere, resolves itself into an objective and subjective division. Under the "objective" we include those indications of disease obvious to the observer, or at least capable of demonstration by some reliable test. Under the "subjective" we have various symptoms for the existence of which we have to rely more completely on the mere statements of the patient, although these also may be susceptible of some scrutiny. As the two sets of symptoms often pass into each other, no separation of them will be made in this chapter.

The Eye.

The examination of the eye affords indications of the greatest variety and importance. No allusion will be made here to diseases of the eye itself, unless in so far as these bear on general diagnosis, or unless they might lead to confusion or error.

The *yellow discoloration* of the conjunctiva is discussed elsewhere in connection with jaundice. For the various points bearing on the diagnosis of jaundice, and on the color of the sclerotic, see "Jaundice," Chapter XII.

Opacities of the cornea, traces of old iritis, and the like, are sometimes useful as indicating, along with notched teeth and other signs, certain constitutional affections, especially syphilis and scrofula. Acute iritis may supervene in syphilitic, rheumatic, or gouty cases while under observation. The cornea may become opaque or may ulcerate from lesions of the fifth nerve, or it may suffer in this way from exposure due to paralysis of the seventh nerve.

The *arcus senilis* consists of an opaque ring or segment of a ring, in the cornea at its junction with the sclerotic. It usually exists in both eyes, when present at all, but it may be present to an unequal extent. It occurs habitually in persons over 60. When present in younger subjects (35 to 50) it is to be regarded as a sign of early degeneration of the tissues; it is very often associated with atheroma, gout, renal disease, and cardio-vascular changes. The complete ring round the cornea is regarded by some as less suggestive of degenerative processes than the segment to which the word "arcus" more properly refers. It would seem that strain on the eyes such as may arise from much microscopic work favors the early development of this change in the cornea.

Suffusion of the eyes, with injection of the conjunctiva and lachrymation, is often due to local inflammation; but we also find it at the beginning of certain fevers, especially measles and typhus. It may likewise constitute one of the early signs of meningeal and cerebral diseases. It is often associated with photophobia.

Photophobia, or intolerance of light, is common to many diseases of the eye (phlyctenular ophthalmia, keratitis, iritis, and retinitis). It is also found in certain stages of meningitis, cerebral tumors, typhus, measles, etc. It is common in many varieties of headaches and especially in migraine. In nervous subjects it may exist apart from any serious changes in the eyeball, there being thus a hyperæsthesia of the retina.

Protrusion of the whole eyeball (exophthalmos) may indicate abscess of the orbit, thrombosis of the cavernous sinus, or tumor somewhere behind the eyeball; in such cases it is usually unilateral. When it affects both eyes, and when associated with enlargement of the thyroid, and rapidity of the heart's action, it constitutes an important element in the diagnosis of exophthalmic goitre. Occasionally the protrusion is much greater on one side than the other in this disease, and in rare cases it may be unilateral; when the patient looks down, the upper part of the sclerotic is unduly visible, from the upper eyelid not following the eyeball in its downward look, and this feature affords us some guidance even when the exophthalmos is slight, or, it may be, still absent on one side.

Complete paralysis of the ocular muscles, or of the third nerve, may lead to a slight protrusion of the eyeball, from the removal of the backward tension of these muscles. Considerable variation exists normally in the prominence of the eyeballs.

Inability to close the eyelids properly (lagophthalmos) is very common, but not invariable, in peripheral paralysis of the facial nerve. (See "seventh nerve," p. 203.) It is uncommon, although not unknown, in the paralysis of the face of ordinary hemiplegia from cerebral causes. Exposure of the eyeball may lead to irritation of the conjunctiva or cornea. From implication of Horner's muscle the tears often run down the cheek.

Ptosis, or droop of the upper eyelid, is a sign of paralysis of one of the branches of the third nerve. Sometimes, however, it is not paralytic, being obviously due to some mechanical impediment to the action of the muscles or eyelids themselves. When paralytic, ptosis may exist alone, or be combined with other evidences of a lesion of the third nerve, or of intracranial disease.

The movements of the eyelids, according to Dr. Gowers, are associated with, and to some extent due to, the movements of the eyeballs. In its downward movement, the eyeball communicates a mechanical depression to the lower lid. In the case of the upper lid, the levator palpebræ is made to act or relax, by an "associated movement," with the concurrent action or relaxation of the superior rectus animated by the same nerve. Hence, in paralysis of the inferior rectus we may have an *apparent* paralysis of the eyelids when the patient tries to look down, from the want of the relaxation of the levator palpebræ usually associated with the contraction of the inferior rectus. We may also have in a case of ptosis, due to cerebral disease, an upward movement of the upper lid when the patient exerts his superior rectus in looking up, although there may be no voluntary power over the levator palpebræ apart from this associated movement.

SQUINTING, OR STRABISMUS—PARALYSIS OF THE OCULAR MUSCLES—DIPLOPIA.—In examining for *strabismus* we get the patient to direct his vision with both eyes open, to a point placed exactly opposite him in the middle line. The observer's finger held in such a position suits quite well. This is tried at various distances, both near and remote, and we notice whether the centre of the cornea coincides with the centre of the palpebral fissure. If a deviation occurs (primary deviation), we should notice whether this comes into more prominence when near or when distant objects are looked at; we also observe whether the eyeball is turned inward (internal or convergent strabismus), or whether it is turned outward (external or divergent strabismus); we can usually say at once which of the two eyes is the one whose axis of vision is directed to the object, and which is the one which deviates. Sometimes, however, the patient can "fix"' the object with either eye indifferently, and so either the one or the other may deviate ("alternate squint"). When the same eye is always used to "fix" the object there is usually a distinct difference in the acuteness of the vision on the two sides—the better eye being, of course, selected by the patient for this purpose. If now we get the patient to "fix" the object with the less perfect eye, by interposing the hand before the sound one, or by placing a piece of dimmed glass in front of it, we may then find that the sound eye (which was quite straight in the former experiment) deviates inward or outward, just as the other did. In many cases this "secondary deviation," as it is called, can be ascertained, by a scale placed below the eyelid, to be exactly equal to the primary deviation: this is the common case when the squint depends on hypermetropia and myopia apart from any paralysis of the ocular muscles ("concomitant squint"); in paralytic squint, on the other hand, the secondary deviation is often more extreme than the primary, and this sometimes constitutes an important indication of ocular paralysis. A deviation, however, which originated in a paralysis in a hypermetropic or myopic patient, may be perpetuated as a concomitant squint after the paralysis has passed away; and in rare cases, from the persistence of a non-paralytic squint, and the stretching of the fibres of the muscle, we may find a want of proper movement from simple muscular weakness aport from any paralysis of nervous origin.

In cases of "*concomitant squint*" there is no impairment of the movement of the eyeballs; this can be shown by testing the eyes separately—only one being open at a time, and the object looked at being carried up and down, and to the extreme right and left; the free mobility of each eye in all directions may then be ascertained. Strabismus having these peculiarities is due to a want of proper adjustment in the action of the muscles, or to a certain shortening of one or other of them; such a squint depends, in the great majority of cases, on errors in the refraction of the eye, convergent squint being associated with hypermĕtropia, and divergent squint with myopia; in a few cases, however, this relationship may be reversed. These errors in refraction are in many cases hereditary, so that a tendency to squinting is often inherited. In such cases of strabismus, binocular or stereoscopic vision is usually sacrificed at an early period in the case, and so the patient is not troubled with diplopia. Specks on the cornea, and other defects in the vision, often seem to determine the occurrence of squinting and the suppression of the vision in the weaker eye. Patients with hypermetropia and myopia may also have squinting very readily induced by various acute illnesses of a general nature; this squint may be temporary or permanent. It may thus simulate a cerebral disturbance under certain circumstances.

In *paralytic squint* the movement of the eyeball is impaired in certain directions, so that it cannot be moved outward or inward beyond the middle line, as the case may be; the sound muscle may also overbalance the paralyzed one, so that, for example, in paralysis of the external rectus we have often an internal squint, and in paralysis of the internal rectus an external squint. Before concluding that there is ocular paralysis, we must see that no merely mechanical impediment exists to hinder the movements. In paralytic squint the "secondary deviation," already described, is often greater than the primary, and when the vision is directed toward the paralyzed muscle, or, more strictly, in the direction of its action, this is often very extreme. Thus, if a person with paralysis of the right external rectus be tested as to his affected eye (the vision of the other being obstructed with a dimmed glass), and if he be directed to look at an object on his extreme right, the nervous energy is directed to the *right* external rectus and to the *left* internal rectus, so as to execute this conjoint movement; as the paralyzed muscle does not respond properly, a still further force is directed to these muscles. and thus the internal rectus of the *sound* eye is led to contract excessively, quite beyond anything that is required, and so produces a marked "secondary deviation;" its pupil may, indeed, be buried within the palpebral fissure.

Diplopia binocularis is common in paralytic squint; indeed, diplopia may constitute the only evidence of a slight paralysis of an ocular muscle; for when this "paresis" (as a slight loss of power is called) is not too great, there may be no discernible diminution of the movements of the eyeball. Diplopia is usually complained of by patients when it is present to any marked extent, but the "false image" is often extremely faint, and the separation of the two images is sometimes slight, or only developed in certain directions of the vision. Moreover, it is important to determine the relation of the two images to the respective eyes, and so a careful test is often demanded. A candle in a dark room, placed at different heights, and in different positions to the right or left of the patient, may be used. It is well also to have a piece of red glass to place before one of the eyes, so as to allow of the identification of each image by its color. If the vision of one eye is less perfect than that of the other, we place the colored glass before the *sound* eye, so as to render the defective image relatively plainer. Indeed, this method may reveal a diplopia which would otherwise escape the patient's attention. The faulty image is usually recognized, apart from this contrivance, by a certain dimness, or obscurity as compared with the other; the false image may be placed at the side of the other; or above or below it; or there may be an obliquity in its position; at times, also, one of the images has a different projection in space, appearing nearer to the patient than the other; these differences depend on the affection being due to paralysis of the superior, inferior, external, or internal recti muscles, or of the superior or inferior oblique, or to various combinations of these lesions.

With regard to the lateral displacement of the false image, we must ascertain whether the diplopia is "crossed" or "direct." If, from the shadowy character of the "false image," or by alternate closing of the eyes, or better still by the assistance of the colored glass *the image to the right* be found to be that which is seen with the *right eye*, then we call the diplopia "direct" or "homonymous." If with the same test we find that the image identified with the right eye is seen to the left, then we call it "crossed." "Crossed" diplopia occurs in paralytic *divergent* squint, or when there is a tendency to divergence of the axes of the two eyes from paresis of the internal recti; "direct" diplopia occurs when there is *convergence* or a tendency thereto.

The images may also be superimposed, the one above the other, and this is usually associated with a certain obliquity in the position of the image seen by the paralyzed eye; this may be slightly "crossed" or not in different cases. (See p. 166.)

In order to facilitate the investigation of these varieties of paralysis the following details are submitted in a tabular form:

FUNCTIONS OF OCULAR MUSCLES.

Rectus superior elevates the axis of vision and slightly inverts the upper part of the vertical meridian of the eye.

Obliquus inferior[1] elevates the axis of vision and slightly everts the upper part of the vertical meridian of the eye.

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[1] The rectus superior and the obliquus inferior are thus required jointly for a *pure* elevation.

Rectus inferior depresses the axis of vision and slightly inverts the lower part of the vertical meridian of the eye.

Obliquus superior[1] depresses the axis of vision and slightly everts the lower part of the vertical meridian of the eye.

Rectus internus inverts the axis of vision.

Rectus externus everts the axis of vision.

OBLIQUE MOVEMENTS.

Elevation with adduction.	Rectus superior and internus with obliquus inferior.
Depression with adduction.	Rectus inferior and internus with obliquus superior.
Elevation with abduction.	Rectus superior and externus with obliquus inferior.
Depression with abduction.	Rectus inferior and externus with obliquus superior.

Hence we find that the position of the eye or of the pupil varies according to the special muscle paralyzed, when the paralysis is of such a degree as to give rise to deviation. Moreover, as this deviation depends on the activity of the sound muscles quite as much as on the weakness of the paralyzed one, the results are not always uniform, as we may have to deal with a complex paralysis. In the following tabular statement only *one* muscle is presumed to be affected, the rest being sound.

RESULTS OF PARALYSIS OF SPECIAL OCULAR MUSCLES WHEN THE OTHERS ARE SOUND.

Paralysis of rectus superior: inability to raise eyeball properly above horizontal level; pupil may diverge somewhat downward, and a little outward (from action of the rectus inferior and the obliqui).

Paralysis of rectus inferior: inability to lower eyeball properly below horizontal level; pupil may diverge somewhat upward, and a little outward (from action of the rectus superior and the obliqui).

Paralysis of rectus externus: inability to turn eyeball properly outward; pupil diverges inward (from action of rectus internus).

Paralysis of rectus internus: inability to turn eyeball properly inward; pupil diverges outward (from action of rectus externus).

Paralysis of obliquus superior: but little alteration in movements of eyeball; slight deviation of cornea upward and inward, or simply upward.

Paralysis of obliquus inferior; but little alteration in movements of the eyeball; slight deviation of the cornea downward and inward. (Paralysis of the sphincter of the iris, giving rise to a moderate dilatation of the pupil, and to paralysis of the accommodation, often accompanies this form of paralysis; this depends on the branch to the lenticular ganglion being given off from that branch of the third nerve which goes to the inferior oblique muscle. Occasionally, however, the lenticular branch arises from the sixth nerve.)

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[1] The rectus inferior and the obliquus superior are thus required jointly for a *pure* depression.

DIPLOPIA IN OCULAR PARALYSIS.

Diplopia is specially, or perhaps only, developed when the axis of vision is turned in the direction in which the action of the paralyzed muscle should be called into play: thus, upward when the elevators are paralyzed, downward when the depressors are involved, and outward or inward in the case of the external and internal recti. Certain actions, as climbing or descending a ladder, may thus bring a diplopia into troublesome prominence; on the other hand, a certain position of the head is often assumed by the patient so as to prevent the tendency to diplopia. In testing, we require therefore to use various positions for the object.

As already explained (p. 164), the diplopia is "crossed" when from paralysis or weakness there is divergence of the visual axes or even a tendency thereto, and for similar reasons we have "direct" diplopia when the tendency is toward convergence. The action of the superior and inferior recti as tending to turn the axis of vision somewhat inward, when their correctors are paralyzed, and of the two obliqui as tending to evert it when the counter-balancing muscles are paralyzed, must also be remembered. (See p. 165.)

HOMONYMOUS AND CROSSED DIPLOPIA.

External rectus paralyzed: diplopia is not "crossed;" images on same level; displacement increased by moving the object outward.

Internal rectus paralyzed: diplopia is "crossed;" images on same level; displacement increased by moving the object toward the sound side.

Superior rectus paralyzed: diplopia vertical and "crossed;" image seen by faulty eye above the other, and somewhat obliquely, chiefly when vision is directed upward.

Inferior rectus paralyzed: diplopia vertical and "crossed;" image seen by faulty eye below the other, and somewhat obliquely, chiefly when vision is directed downward.

Superior oblique paralyzed: diplopia vertical and not "crossed;" image seen by faulty eye below the other, and somewhat obliquely, chiefly when vision is directed downward.

Inferior oblique paralyzed: diplopia vertical and not "crossed;" image seen by faulty eye above the other, and somewhat obliquely, chiefly when vision is directed upward.

Instinctive efforts to combat the diplopia are often observed in patients, as the presence of the "false image" gives rise to a feeling of distress, and is apt to lead to error and confusion in estimating the position of objects. The most natural and intelligible counteracting movement is the closing of the affected eye, and so at first sight it may seem that the patient has ptosis: the drooping of the upper lid, however, is readily seen to be due not to paralysis of the levator, but to a voluntary action or even to a spasmodic contraction of the sphincter.

Again, the diplopia is developed, in a case of paralysis of the abducens, because the patient cannot direct the eyeball outward, and the diplopia becomes marked in proportion as the object looked at calls for this action. But although the patient cannot turn the *eye* outward he can rotate the head in this direction, and by maintaining the head in such a position as to supplement the action of the weak muscle he can often minimize the troublesome diplopia. These habitual deviations of the head become in this way suggestive of special forms of ocular paralysis.

POSITIONS OF THE HEAD IN OCULAR PARALYSIS.

In paralysis of the sixth nerve the face is turned toward the paralyzed side.

In paralysis of the fourth nerve the face is directed downward and toward the shoulder of the paralyzed side.

In paralysis of the third nerve the face is turned habitually toward the shoulder of the sound side to combat the weakness of the internal rectus. Special positions of the head upward or downward may be required in ascending or descending, owing to the elevators and depressors being likewise paralyzed. Sometimes, from the presence of ptosis also, no effort is required to avoid the diplopia, as the vision exists then only on the sound side.

The Clinical Significance of Squint, Ocular Paralysis, and Diplopia.—When a squint is not of paralytic origin it has not much significance to the physician, but on this very account it is important that he should be able to distinguish such cases. Occasionally a squint originates in a paralysis, although this may have passed quite away; in such a case it has some significance in the history. But it must also be remembered that in subjects predisposed to strabismus by optical defects, a concomitant squint may originate in connection with any acute illness quite apart from paralysis.

When a squint is due to paralysis of the third, fourth, or sixth nerves (see pp. 202, 203) it has great significance. As a rule, these nerves are affected by lesions at the base of the brain, or the base of the skull, so that some interference with the nerve itself *in its course* is indicated, rather than a lesion at its deep origin; the lesion is thus on the same side as the paralyzed muscle. Hence these nerves are specially involved in cases of cerebral tumor and basal meningitis; they are all very frequently paralyzed from syphilitic disease within the skull. When one of these nerves is involved, the other cranial nerves must also be examined, as combinations of paralysis of the sixth nerve with patches of anæsthesia in the region of the fifth, for example, are even more suggestive of syphilitic lesions. Paralysis of the fourth nerve is usually due to syphilis. Paralysis of these three nerves, however, and especially of the third, may often be classified with the so-called "rheumatic" paralysis—that is, they seem to be induced by cold.

Paralysis of the third nerve, when complete, includes droop of the upper eyelid (ptosis), paralysis of all the muscles of the eyeball except the external rectus and the superior oblique, dilatation of the pupil, and some defect in the power of accommodation. This paralysis of most of the muscles leads to great deficiency in the mobility of the eye, as already explained, and the pupil is directed outward and somewhat downward. The paralysis of the sphincter of the iris should be specially studied in connection with the signs of paralysis of the inferior oblique muscle (occasionally, however, the supply to the iris comes from the sixth nerve). The dilatation of the pupil in paralysis of the third nerve is only moderate in degree; it can be rendered much more extreme by the use of atropine. Extreme dilatation of the pupil, therefore, may suggest some *irritation* of the sympathetic, when there is no question of the use of atropine or other mydriatics. The various branches of the third nerve may be paralyzed separately, so that we may have ptosis alone, or external deviation alone, or dilatation of the pupil, or paralysis of the accommodation, or various combinations up to the most complete paralysis of the nerve.

Diplopia (double vision with both eyes open) may be associated with a paralytic squint, or it may furnish the only evidence of paresis in the ocular muscles which may not be extreme enough to lead to squinting. While diplopia is extremely common in paralytic squint, it is extremely rare in the ordinary forms of squinting associated with optical defects; indeed, even in ocular paralysis the diplopia may cease when the squinting becomes very pronounced and the affection chronic. The special forms of diplopia and their bearing on the diagnosis of paralysis in special muscles have already been referred to (p. 166).

Diplopia is sometimes complained of by adults at the very beginning of cerebral meningitis, probably from the inflammation leading to a slight paralysis of the nerves. It is also produced in some persons by much less serious disturbances: derangements of the digestive organs, for example, may bring on diplopia and the somewhat allied symptom of vertigo. In certain cases of alcoholic intoxication there is a want of due adjustment in the complex movements of the eyeballs leading to double vision; a similar condition is found in the early stages of locomotor ataxy arising from want of coördination, apart from squinting or any profound, or at least permanent, paralysis of the ocular muscles; this must be distinguished from the paralysis and squinting of a more permanent nature found in the later stages.

Diplopia and strabismus, even when due to disturbance of the brain, are both particularly apt to occur in those whose eyes are not normal in their refraction.

Diplopia monocularis can be readily distinguished from the diplopia just referred to, as this double vision occurs while using a single eye. This is comparatively a rare symptom, and is almost invariably due to some error in the eyeball itself. Irregularities of the crystalline lens or cornea and the presence of artificial pupils are the recognized causes of this affection. Spasmodic affections of the accommodation, hysteria, mental disorders, and cerebral tumors have, however, been alleged as occasional causes of the disorder.

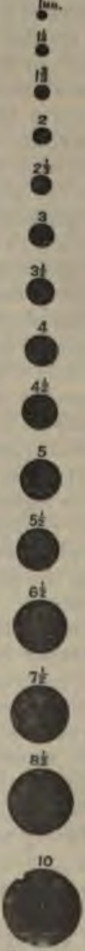
Erroneous Projection, Ocular Vertigo.—An erroneous estimate of the position of objects is common in cases of paralysis of the ocular muscles, so that a person (say) whose right external rectus is affected, when asked to strike an object placed on his right, or to walk toward such an object, is often found to aim at a point too far to the right; this probably arises from the mind being conscious of an unduly great energy being directed to the paralyzed muscle in the vain endeavor to get it to act; it appears probable that the position of objects is estimated from this "out-going current," as it is termed. This erroneous estimate of the position of objects in certain directions leads to constant confusion from the changes which occur in the apparent position of objects as the person walks along or even moves his eyes; hence arises the "monocular vertigo" which occurs in cases of paralysis of the third nerve, for example, if the sound eye be closed and the drooping lid be held up as the patient walks along. A somewhat analogous confusion and vertigo may result from binocular diplopia, or from conditions bordering on this state; the patient often places his head in such a position as to lessen the displacement of the images or closes the affected eye altogether. In paralysis of the ocular muscles the closing of the sound eye does not abolish this monocular vertigo. An erroneous estimate of the position of objects, or of the position of the false image in diplopia, from an apparent *forward* displacement, is found to occur in certain cases of ocular paralysis, particularly when the fourth nerve and the superior oblique muscle are involved.

PUPILS. *Equality or Inequality.*—Normally the pupils are equal; they dilate considerably in the dark and contract when exposed to light. Occasionally, however, the pupils are unequal congenitally, and the response to light diminished in the eye whose pupil is already contracted (congenital myosis). In examining such cases we should do so while they are shaded from any bright light. Inequality of the pupils is occasionally found in some persons (congenitally?) along with other indications of an affection of the sympathetic, such as unilateral sweatings. Old iritis sometimes accounts for the contraction and immobility of the pupil observed; this can usually be made out by detecting traces of exudation, or some irregularity in the outline of the iris, especially on dilatation with atropine, or the exudation may be seen on the capsule of the lens on ophthalmoscopic examination. As iridectomy is now so common, the student must learn to recognize an artificial pupil. The possibility of an eyewash containing belladonna, atropine, cocaine, or some other mydriatic being used must never be forgotten in the inquiry; occasionally a little belladonna gets into an eye quite accidentally. The action of belladonna in dilating, or of Calabar bean in contracting, an abnormal looking pupil, affords assistance in the study of this abnormality in special cases. This has been recommended as a test in distinguishing paralytic from spasmodic changes in the pupils; the distinction between spasm and paralysis, although, it should be kept in view, has not yet been sufficiently clearly differentiated.

Apart from these circumstances, inequality of the pupils is always a fact of great importance as indicating—(1) in cases of dilatation—some lesion of the third nerve, the significance of which must be estimated by considering whether the other branches of this nerve are involved. Irritation of the sympathetic (as distinguished from paralysis) has likewise been supposed to lead to dilatation of the pupil. In cases of this kind we must search for evidence of disturbance of the sympathetic, and we must see if any of the cranial nerves are affected. (2) Abnormal contraction, that is, the absence of any considerable dilatation when shaded from the light, may be due to some affection of the sympathetic in the neck, or of the cervical spinal cord (spinal myosis; idiopathic affection or wounds of, or pressure on, the sympathetic in the neck from tumors, especially from aneurisms); it is also common in general paralysis of the insane. (3) The inequality may be due to some unilateral lesion of the brain, or perhaps to unequal pressure of fluid on the two sides of the brain in cases of injury or effusion. Even when due to serious disease the inequality does not always preserve the same degree, and, indeed, is not always persistent.

Alterations in the size of both pupils are likewise important. The absolute size of the pupils may be measured by applying the holes of a catheter gauge over the pupil, taking them in succession till one is found to agree. Or the diameter in millimetres may be pretty accurately estimated by the eye on comparison with a series of black spots. Such a scale is included in Nettleship's pocket case of tests for the eye; the sizes selected by him are those reproduced here; in his scale the black spots are printed on tinted paper to resemble so far the background of the iris. On holding this series of spots by the side of the pupil, the eye can usually read off the size with confidence. (See Fig. 32.) A statement of the size in figures is much more satisfactory than descriptive or figurative words such as "pinhole pupils," etc. The normal size varies from about three and a half millimetres to seven and a half millimetres according to exposure to light, the influence of age, etc. Sometimes the pupils are unduly dilated or contracted, and sometimes they fail to respond to the light in the usual way. Contraction of the pupils may be produced by the use of opium, and this affords a valuable means of diagnosis in cases of suspected opium poisoning, and also in estimating the effect which opium, as a medicine, may have had on the system. Belladonna and atropine, administered internally or absorbed

FIG. 32.



Pupillometer. The figures express the diameter in millimetres.

through the skin or mucous surfaces, as well as applied to the eye and brow, produce well-marked dilatation of the pupil; if applied to one eye they act only on one side. Calabar bean, applied to the eye or given internally, causes well-marked contraction. Atropine and Calabar bean seem to have a special and direct stimulating influence on the radiating and circular fibres of the iris, respectively, in addition to any paralyzing effect on the nervous supply. Alcohol and chloroform likewise affect the pupil, but in rather an uncertain way, due in part, perhaps, to their dose, and to their varying effect on the system; other agents also have at times an action on the pupil. In profound alcoholic coma the pupil becomes contracted when the patient is left undisturbed; on shaking or trying to rouse him, the pupils dilate, without other signs of consciousness showing themselves, and after five or ten minutes slowly return to their contracted state. (Macewen.) A somewhat similar reaction, with more rapid return to the contracted state, is sometimes seen in apoplexy. In cerebral diseases the pupils are often unduly contracted or dilated, but it is scarcely possible, in the present state of our knowledge, to lay down any general doctrine on the subject. In simple serous effusion, in meningitis with effusion, and in many cases of apoplexy, the pupils are dilated, and this is usually reckoned among the "pressure signs." In not a few cases of apoplexy, however, the pupils are contracted, and this is seen in some of the worst and most rapidly fatal forms of hemorrhage (in the pons). In epileptic fits the pupils are often contracted during the fit and dilated after it. The student must content himself with noting the state of the pupils, reserving the significance of the sign for further consideration and study in view of the whole facts. In cases of total blindness of both eyes the pupils are permanently dilated, unless, indeed, there be adhesion of the iris. In typhus fever, especially in the stage of delirium, the pupils are usually contracted; in enteric fever, on the other hand, the pupils rather dilated. In the uræmic poisoning of renal disease the pupils are only moderately contracted as a rule. During natural sleep the pupils are contracted; this can often be seen by gently raising the eyelids; the pupil then dilates as the person awakes, and if the light be bright it immediately contracts again under this stimulus. Under moderate doses of chloral the behavior is the same as in natural sleep.

Reflex dilatation of the pupil may be produced in the healthy subject by pinching the skin, especially near the eye, and this test is applied in studying the other pupillary reflexes—response to light, and the contraction during the act of convergence and accommodation, Under the influence of great pain the pupils often dilate, and likewise under various states of emotional excitement. Habitual dilatation of the pupils is sometimes noticeable in boys addicted to masturbation. Just before death the pupils almost always become dilated, even if they have been contracted before (say from opium); soon after death, however, they undergo contraction to a varying extent.

Rhythmical alternations in the size of the pupils can often be seen in "Cheyne-Stokes respiration." The pupil contracts during the period of apnœa, so as to resemble the state found during sleep; with the first few breaths of the ascending series the pupil begins to dilate, to contract again as the respiration stops. Sometimes a rhythmical contraction and dilatation can be seen with every respiratory act during the full deep breaths of the "Cheyne-Stokes respiration:" similar alternations with each breath have been noticed during the stertorous breathing of coma; the pupil dilates with the inspiration and contracts with the expiration.

The sensitiveness of the pupils to light should be tested by first covering the eyes with the eyelids and fingers, and then opening them suddenly; or by keeping the lids open and shading the eyes from the light and suddenly exposing them again; the degree and rapidity of dilatation and contraction may be thus observed. Light from a taper or candle often suits better than daylight, as its direction is more under control, or the light from an ophthalmoscope may be suddenly directed upon them. This test is sometimes applied to discover the sensitiveness of the retina in those who are unconscious or unable to express themselves. In such cases we may have contraction of the iris in a blind eye through the influence of light on the other, if it be sensitive, and there may be likewise a sympathetic dilatation; hence it is better to test the eyes separately. For similar reasons a dilated pupil on one side may, by admitting more light, lead to an excessive contraction of the other. The amount of variation on exposure to light is usually greater in young persons, and when the pupils are naturally large. The sensitiveness of the pupil to light is often much diminished in apoplexy, and also when there is effusion of any kind on the brain. In some cases of meningitis the pupil is affected by light, but instead of contracting it, oscillates—*i. e.*, varies between contraction and dilatation in a curious way. (Tremulousness of the iris itself, backward and forward with a wave-like motion, arises from undue fluidity of the vitreous, probably combined with rupture of some portion of the ligament of the lens, and is only of ophthalmic interest.) When the pupils are much dilated or contracted from the influence of drugs, or from paralysis, or from congenital peculiarity, they are not readily affected by light.

Contraction of the pupil during the act of accommodation and convergence is a normal occurrence. Occasionally it is found that pupils which do not respond to light may contract during accommodation for near objects. This is found chiefly in cases of locomotor ataxy, and this reaction of the pupils is named, from its discoverer, the "Argyll Robertson pupil" or symptom. The pupils in such cases are usually small. The influence of stimulation of the skin may be tried as a comparison.

The accommodation of the eyes for distinct vision of near objects becomes defective with age (about forty-five or fifty years of age); this "presbyopia," as it is called, is probably due, in part at least, to changes in the lens itself; such defects become more pronounced and occur at an earlier age in those who are hypermetropic, and so require to use their accommodation even for distant vision. The accommodation may be defective from some nervous lesions, or when the third nerve is paralyzed, and diphtheritic paralysis of the accommodation is not uncommon. The size of the pupil is not always affected when the accommodation is paralyzed, although both are very often involved together. When the vision is defective from this cause convex glasses (+ 12 or 3 D.) should correct it fully, provided the person's refraction is normal (emmetropia). Atropine, cocaine, etc., paralyze the accommodation *pro tempore.*

Ophthalmoplegia externa: Ophthalmoplegia interna.—These names are applied to paralytic affections involving the muscles of the eye. The *external* form implicates the levator palpebræ and all the muscles attached to the exterior of the eyaball. It is usually bilateral, but may affect the two sides with unequal severity. The pupils may be more or less implicated, and there may be loss of vision and atrophy of the optic nerve. It has been ascribed to syphilis and rheumatism. The *internal* form implicates the muscles which effect the movements of the pupils and the power of accommodation. It is supposed to be due to an affection of the lenticular ganglion, and can sometimes be ascribed to syphilis. Details as to the special muscles implicated will be found in the preceding sections.

Strain on the eyes, a sense of fatigue readily induced, and a great tendency to confusion of the lines and words in a book, after reading for a few minutes, constitute the indications of "asthenopia." This strain may be prolonged or intensified to a great extent, and may give rise to headache of such a character as to suggest cerebral mischief. This excessive strain may be due to some specially exacting form of work arising in connection with the constant and extreme demands made on the power of the accommodation or of the convergence; sometimes, indeed, the combination of different and unnatural degrees of accommodation and convergence may produce this strain, particularly in those who use glasses. These excessive demands arise in connection with optical defects of the eye—hypermetropia, myopia, astigmatism—in the last the varying demands are incessant and most exacting; these defects are often complicated with weakness or "insufficiency" of the internal recti muscles. The headaches arising from the strain thus produced, although at first induced directly by taxing the eyes, may continue in a more permanent form, so as to give little or no suggestion of an ocular origin of the disorder. Some of the defects cause a constant strain on the eyes, which cannot be relieved by any amount of apparent rest.

Muscæ or motes are to be distinguished according as they are fixed or floating. Muscæ volitantes—motes floating about in the field of vision—may be seen by any healthy eye, and in such cases they are due to minute opacities normally existing in the vitreous. They may be demonstrated by looking at a light through a minute hole in a blackened card; in this way the shadows of the opaque objects are projected on the retina. Motes like strings of beads, and also motes darting in various directions, may be seen at times apart from disease, especially on looking at dazzling white objects; these latter are essentially subjective and appear to be due to disturbances in the circulation. Muscæ are usually more obtrusive in myopic eyes, and in conditions of weakness and irritability of the retina from whatever cause. Motes from normal opacities must be distinguished from floating specks due to abnormal opacities in the vitreous; the latter are generally visible with the ophthalmoscope. Fixed muscæ—fixed black spots or bands—are due to opacities in the substance of the retina. Opacities in the lens are revealed by ophthalmoscopic illuminations as black bands or streaks, but they are not perceived by the patient as such, unless by some such device as the experiment with the blackened card, just described.

Flashes of light (photopsia) are produced by irritation of the retina, or of the optic nerve in any part of its course from the brain. Even gentle pressure on the eyeball gives rise to circles of light or phosphenes, and blows produce more violent flashes in the same way; such sensations are frequent in incipient disease of the optic nerve. Flashes of light are likewise often complained of by those whose cerebral arteries are rigid, and in whom disturbances of the circulation in the optic nerve, or in the cerebral centres connected with it, may be presumed to exist; they are recognized as amongst the prodromata of apoplectic and other cerebral seizures.

Colored spectra (chromopsia) are of somewhat similar nature; they have been known to usher in epileptic fits. *Yellow vision* (exanthopsia) is observed in certain cases of jaundice, but it is rare, at least in a highly marked form; it is occasionally produced by santonine administered internally; this predominance of yellow renders the recognition of red difficult.

Convulsive movements of the ocular and palpebral muscles may occur as independent functional affections of the eye; they then come more properly under the notice of ophthalmic surgeons, but they sometimes serve to indicate cerebral mischief. Spasm of the orbicularis palpebrarum (blepharospasm) occurs in cases of intolerance of light, or from other forms of reflex irritation, and is often associated with hypermetropia; but twitchings and remittent spasms of this muscle may, if severe, be due to central causes, resembling thus certain forms of convulsive wry neck, twitchings of the trapezius, etc.

Nystagmus (convulsive rhythmical movement of the eyeball) occurring as a simple ocular affection, and dating from early life, need not be noticed here. The movements are usually lateral, rarely vertical: sometimes they have more of a rotatory character. They are often of but limited extent, and of extreme rapidity; frequently they require close observation to detect their presence. Nystagmus seems also to be developed in connection with particular occupations, as in coal-miners and some others. It is also, however, met with as a symptom of definite disease of the nervous centres: it sometimes appears in one eye only, but usually in both. The movements can often be seen at the beginning of fits, and are then regarded as part of the convulsion. Sometimes they are associated with a peculiar deviation of the eyes, both eyes being directed as if the patient were trying to look fixedly toward the back of his shoulder (conjugate or lateral deviation of the eyes); associated with this there is often, if not usually, a turning of the head also in the same direction. The significance of this combination will be referred to in connection with these other symptoms. Frequently the oscillations of nystagmus can only be detected when the patient looks steadily in a given direction to the extreme left or right, and in such cases there is sometimes associated with it an appreciable paresis of the muscle called thus into play—*e. g.*, of the right external rectus when the nystagmus appears on looking steadily toward the extreme right. On the other hand, there is sometimes in nystagmus a point at which the eyeballs rest when the vision is directed there; this is especially seen in miners' nystagmus. In cases of cerebrospinal sclerosis nystagmus is an important symptom; it is sometimes present to a glaring extent, but sometimes it requires to be searched for by directing the vision steadily to special points.

Conjugate or lateral deviation of the eyes differs from squint inasmuch as the two eyes have their axes of vision parallel, although both are deviated from the middle line. With this we have often a rotation of the head at the same time; the patient has then the appearance of regarding fixedly something over his shoulder, for *almost* always the eyes look in the same direction as that to which the head is turned. The deviation of the eyes, however, may occur apart from any rotation of the head.

This curious symptom is found in connection with the occurrence of convulsions and also at the onset of certain hemiplegic attacks. In the former, the symptom appears to be itself due to convulsion or spasm of the particular combination of muscles (on both sides of the body) by which the movements are executed. At other times it appears that the movements are performed by the sound muscles, which contract strongly owing to the balancing action of their antagonists being suddenly lost from paralysis. The symptom points strongly to a gross lesion of the brain on one side, although it has been noted in idiopathic epilepsy also. The side to which the deviation takes place varies apparently with the cause; the following is the doctrine which has been formulated:

(*a*) If associated with convulsions it may be presumed that the deviation is due to *spasm;* hence it should be toward the convulsed side when the convulsion is unilateral and so presumably due to a lesion on the opposite side of the brain; the patient will thus look away from the side of the brain on which the lesion may be presumed to exist, (1) provided such lesion is in the *hemispheres or peduncles:* (2) in lesions of the *mesocephalon*, however, the direction is reversed, and the patient then looks away from his convulsed limbs if the convulsions are unilateral.

In this convulsive form the muscles of the neck are more rigid than in the paralytic, the head is replaced with more difficulty, and if conscious the patient may even complain of pain on moving it back.

(*b*) In the *paralytic* form of the lateral deviation, the symptom is found in connection with somewhat sudden apoplectic attacks; (1) if the eyes are turned away from the paralyzed limbs the lesion is supposed to be in the *hemisphere;* (2) if they look toward the paralyzed limbs the lesion is supposed to be in the *mesocephalon.* In this paralytic form the rotation is attended with less rigidity of the neck, and the head can be restored to its natural position without much trouble, and without indications of pain if the patient is conscious.

The distinction between conjugate deviation of the eyes and strabismus is usually perfectly clear, but occasionally we have a combination of these conditions, in a somewhat imperfect form, in cases of paralysis of the sixth nerve. When this lesion exists alone, and is due to an affection of the nerve trunk, we have of course a convergent squint, at least in certain directions of the vision. But when the mischief is due to a lesion at the origin of the nerve in the fourth ventricle ("nuclear paralysis"), we certainly sometimes have a conjugate deviation of paralytic origin, both the eyes being directed away from the external rectus implicated. This arises from the external rectus of one side acting habitually in harmony with the internal rectus of the other, probably in virtue of some crossing of the fibres from the nucleus of the sixth nerve on the one side, to the nucleus of the third nerve on the other; such an arrangement would, of course, facilitate the synergic action in the lateral movement of the eyeballs in the normal state. On this view we have the internal rectus of one side animated, *in part*, by a nervous supply from the origin of the sixth on the other. If then we have a nuclear paralysis of the sixth nerve on the right side, for example, we will have not only paralysis of the *right* external rectus but weakness of the *left* internal rectus; and so instead of an internal squint of the right eye (or deviation of this eye to the left), we have conjugate deviation of both eyes toward the left side.

The acuteness of vision affords indications as to the state of the optic nerve, but of course the vision may be interfered with by many local causes which have no special significance to the physician (opacity of the media, closed pupil, separation of the retina, etc.): moreover, the advance of age lessens and abolishes the power of accommodation (presbyopia), and there may also be a paralysis of the accommodation from nervous lesions or the action of drugs. Optical defects (hypermetropia, myopia, and astigmatism) often produce imperfect vision, and so may simulate an impairment of the optic nerve. These subjects must be studied in detail at the eye infirmaries, but with a few precautions the use of Snellen's test-types[1] affords a valuable means of testing the vision; the different numbers of his scale can be read fluently by an average eye at the corresponding number of feet[1] or metres (No. 1½ at a foot and a half, No. 20 at 20 feet; or 0.5 at half a metre, etc.); lines and spots are given which may be counted by those who are unable to spell the Roman capitals. In using the types both high and low numbers should be used at corresponding distances. The difference between the nearest and furthest points at which the smaller types can be read indicates the range of the accommodation; but a full examination demands in certain cases the use of lenses also.

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[1] Test-types for the Determination of the Acuteness of Vision, by H. Snellen, M.D. Fourth edition. Williams and Norgate, 1868. Also, Optotypi ad Visum Determinandum, Editio quinta. Metrico Systemate. 1875.

The degree of hypermetropia is estimated by the *strongest* convex glass with which the person can read No. 20 at 20 feet, or the corresponding types at 6 metres; this represents the "manifest hypermetropia." But when the accommodation is completely paralyzed by the repeated application of atropine, especially in young subjects, a stronger lens may be required, this addition being the index of the "latent hypermetropia." In the case of myopia the *weakest* concave glass sufficient to render No. 20 visible at 20 feet (or the corresponding types at 6 metres) is reckoned the measure of the myopia. When such lenses improve the vision without rendering it perfect, astigmatism should be tested for; some circular arrangement with radiating lines may be used, or the dial of a clock, to see if all the figures on the circle and the hands in the various positions are perfectly straight and equally distinct. When by suitable glasses the person can read No. 20 at 20 feet (or at 6 metres in the other scale), we reckon the vision good, the presumption being that any defects are merely due to optical causes. In many such cases, however, the correction is not absolutely satisfactory, especially in myopia.

It must be remembered that there may be a marked affection of the optic nerve although the person may be able to read the smallest types quite satisfactorily.

Defect of visual acuteness is often spoken of as "amblyopia" and complete blindness from nervous causes as "amaurosis." We often find these due to grave lesions of the retina or of the nervous centres, and it is on this account that the examination is so important to the physician as furnishing evidence of Bright's disease of the retina, cerebral tumor, or meningitis. But dimness of vision may arise from other causes of somewhat less serious nature, as in anæmia from loss of blood, prolonged discharges as in leucorrhœa, and protracted suckling: even suddenly assuming the erect posture in cases of debility and feeble circulation from whatever cause, may bring on dimness of vision. In other cases the dimness of vision may be due rather to weakness in the muscular apparatus of the eyes which regulates the convergence and accommodation, and these may be weak from general causes as well as from the local strain on the eyes already referred to (p. 175).

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[1] Parisian feet, which are slightly longer than English; proportion, 46–49.

In the fifth edition the metrical system is followed, beginning at 0.5, 0.6, and so on in fractions of a metre.

The *field of vision* should be estimated in certain cases, as it is often of great importance in medical practice; it is found to be much diminished in some affections of the optic nerve, due to cerebral as well as to more local causes. Each eye should be tested separately; the line of vision of the patient is to be directed steadily forward, to meet the gaze of the observer's eye seated immediately opposite him, and the observer's finger or some luminous object in his hand should then be carried to the extreme left and right, and above and below, till the limit is reached at which it is visible while the eye is kept looking straight forward. In this way the observer can watch whether the patient's vision is kept steadily fixed; at the same time he can compare the extent of the field of vision in his own right eye with that of the patient's left (and *vice versa*)—using his own eye as an approximate standard. Ophthalmic surgeons have more accurate methods of measuring and reducing to a scale the field of vision by means of a perimeter, but the above method is a ready means of forming a fair general estimate. The field of vision is sometimes contracted almost equally in all directions, but the defect is usually in particular directions, such, for example, as the upper and inner half.

Local defects in the field of vision may be detected in connection with localized lesions in the retina, and of course these are more troublesome to the patient when they happen to be central. In the absence of a visible lesion in the retina a central amblyopia may be due to a latent choroiditis or to some serious lesion of the optic nerve; it has appeared frequently to be due to poisoning by tobacco, or perhaps alcohol, and in a few instances to a hereditary defect.

Hemiopia.—When the defect is limited to one-half of the field of vision the affection is named hemiopia or hemianopsia, and patients may complain that they see only one-half of an object. It is rare for an upper or under half to be involved; sometimes a less segment than a half is implicated. It is usually a lateral half which is lost, and the defect is named according to the unseen portion; thus if the half of the object to the patient's right be unseen with the right eye we term this "temporal hemiopia," or perhaps better "temporal hemianopsia" of that eye. The defect in the retina is, of course, in the opposite or nasal half to bring about this result, the temporal half being sound; the etymological accuracy of the term "temporal hemiopia" is, therefore, not interfered with; in speaking of a defect, however, perhaps "hemianopsia" is a more suitable word. One eye only may be involved, but both eyes are usually affected simultaneously; the most common combination is temporal hemianopsia of one side and nasal of the other (homonymous.) When two nasal halves or two temporal halves are involved simultaneously the resulting defect is, of course, much less obvious to the patient; it may, indeed, readily escape his notice—the deficiency in the half of the field of vision in the one eye being supplemented by the sound half of the other associated with it in binocular vision.

Occasionally hemiopia is combined with hemianæsthesia, the patient's vision is defective on the side with which he would try to look on his affected limbs. Sometimes hemiopia is found in hemicrania (migraine) and passes off with the other symptoms of this functional disturbance. When due to actual lesions, we usually find it associated with tumor or hemorrhage. The optic nerve, the optic commissure, or optic tract, in some part of its course, are usually the structures implicated, but sometimes the mischief appears to exist in some deeper cerebral centre. The curious limitation of the defect to one lateral half of the retina depends no doubt in most cases on the decussation of the fibres at the commissure; but the occurrence of some decussation at the cerebral centre for vision would almost seem necessary to explain the implication of both eyes in some of the cases of unilateral cerebral lesion.

If a tumor is in the front of the chiasma, we can understand that the two inner halves of the retina would be involved, while implication of one optic tract would give us the common combination of an outer and inner half of each retina; thus a lesion of the left optic tract would affect the left half of each retina giving thus right homonymous lateral hemianopsia.

Color-blindness (achromatopsia) is not uncommon as a congenital or even as a hereditary defect. Red and its compounds and green are the colors most commonly concerned.

No special significance can, as yet, be attached to this defect. A degree of color-blindness, however, is often found in connection with blind spots in the central part of the retina, and so it should be investigated in cases of optic neuritis and atrophy, and in the study of tobacco poisoning with central amblyopia. We may, however, have a scotoma for a particular color without any loss of the general visual acuteness. Color blindness likewise complicates hemianæsthesia. The field of vision for the various colors is not equally extensive in the normal state, and in certain nervous affections it is notably curtailed for certain colors. The field of vision for colors may be tested in the same way as the general field of vision—various colored objects of suitable size being substituted for the white luminous object. *Dyschromatopsia* is the term applied when there is difficulty in distinguishing colors without absolute color-blindness.

For testing the color sense the most generally convenient plan is to supply the patient with a large number of skeins of colored wools of various shades; we then give him a good, bright sample of red and of green, in particular, and ask him rapidly to sort all the shades of red into one lot and of green into another. He should be placed in a good light, but he should not be allowed to scrutinize the skeins too closely. In supplying the samples a variety of shades must be used, and especially pinks, rose colors, pale greens, stone, gray, slate, and drab colors, as these are the most generally confused; the larger the number of shades sorted correctly the clearer is the evidence of a correct color sense. Other colors may also be given or the whole bundle with all the colors may be given for him to classify according to their colors.

Hemeralopia, called also "night blindness," consists in the inability to see properly toward evening, as the daylight declines. It is found in soldiers and others who have been exposed to dazzling lights. It has no special significance to the physician. This symptom is found also in the affection known as retinitis pigmentosa. (Hemeralopia is employed by some in exactly the opposite sense, the term *nyctalopia* being then used for night blindness.)

Ophthalmoscopic examinations are useful (1) in discovering whether the loss of vision, which may be detected, is due to other than nervous lesions; (2) in distinguishing various affections of the retina and optic nerve from each other; and further, (3) marked changes of much diagnostic significance are sometimes discovered when there is no affection of the vision as tested by types. The use of the ophthalmoscope must be learned practically in the dark rooms of our eye infirmaries, and no description of the instruments or the methods of using them would be here of much use. The methods by the erect and inverted images are both used for medical cases, but for the more delicate examination of the nervous and vascular changes the direct method is preferable. The student should aim at making himself familiar with both methods, and should, by examining many eyes, apart from any cerebral affections, learn to distinguish the varieties in the size, shape, and appearance presented by the optic nerve, whether congenital or acquired, and in particular the changes in the fundus so often associated with hypermetropia and myopia. He should also learn, if possible, to estimate the degree of hypermetropia or myopia and the presence of astigmatism, by means of the ophthalmoscope, as in many cases in *medical* practice no other method is available.

The following are the points specially to be attended to in using the ophthalmoscope in medical cases: *The shape of the optic disk* should be noted; if both disks are oval in the same direction, instead of being circular, optical defects (astigmatism) should be tested for, before concluding that there is a real change. We also ascertain the presence or absence of the *congenital cup*, or any excess of cupping (as in glaucoma); or any filling up of the cup; these points can be made out by observing the course of the vessels and by estimating the focal depth. *The course of the bloodvessels over the disk* must be scrutinized; in particular, let it be noted whether the arteries appear to project forward on the disk, or to curve over its edge from its swollen state ("choked disk," œdematous papilla).

The size and appearance of the large arteries should be noted: whether they seem diminished in calibre, and whether they appear glistening and as if affected with sclerosis, or accompanied with whitish streaks. These streaks are found associated both with intraocular and with cerebral disturbances; in the former (hypermetropia) the acuteness of vision is not diminished, but in cerebral cases giving rise to this condition of the arteries, the vision is almost always affected; streaks over the centre of the vessels do not indicate serious changes, and are due probably to mere reflection of the light The vessels may be abolished by *embolism* or *thrombosis* of the retinal artery or of one of its branches; this accident is characterized by sudden blindness; at first there is a whitish patch of exudation with a red spot, marking the position of the macula; this exudation disappears, and the color returns in a few days, but the vessels soon become obliterated, and the blindness is parmanent. *The veins* should be noted as to the presence of enlargement or tortuosity, and as to whether they seem specially dark and congested where they dip into the tissue of the nerve. *The size and color of the disk* are very important; attention must be directed to see if it is unduly pale or of a bluish or greenish tinge, and the distribution of pigment around its margin, if any be present, must be noted. The disk is often pinker than normal, shading off so gradually into the color of the retina as scarcely to be distinguished from it (neuritis); or the edges may be veiled by exudation. On the other hand, the disk may be unduly pale, with a deficiency of the minute vessels distributed to its substance (white atrophy, sclerosis). The disk itself may be normal or pale, even although the large vessels in front of it are increased in number. The size of the disk may remain normal although the condition known as white atrophy is highly marked, but the nerve may be shrunken as a whole or in particular parts (atrophy with loss of substance, or contraction). *Traces of exudation*, either in patches or in the course of the vessels, are sometimes found associated with a general pink and prominent aspect of the disk, which assumes a woolly appearance ("choked disk"). The bloodvessels should also be examined in their course, particularly as to the *presence of hemorrhages;* these should be noted as to whether they seem true clots, or whether the vessels seem to terminate in branching-like spots involved in patches of white exudation; mere dark spots from a sudden bend must be distinguished from hemorrhages. When reddish spots without any true clot are found, miliary aneurism may sometimes be suspected, particularly at bifurcations of vessels. *Large exudations* forming irregular patches, partly on the nerve and partly beyond it, or connected by streaks with the disk, obscuring the vessels and associated with loss of vision, are to be suspected as syphilitic. *Whitish pearly spots of exudation* in the neighborhood of the macula lutea are common in Bright's disease of the kidney, and large patches, with smaller glittering spots elsewhere, are also found in this affection; somewhat similar patches are seen occasionally in diabetes and some other affections. *Shining miliary tubercles* are occasionally seen in the choroid in cases of tuberculosis and tubercular meningitis.

Significance of Ophthalmoscopic Appearances in Medical Diagnosis.—Optic neuritis and optic atrophy are the two most important conditions discovered in the fundus in the examination of medical cases. Optic neuritis regarded as an affection of the nerve in its course cannot be differentiated clinically from inflammation of the "papilla," as its termination within the eye is called. To inflammation of this part the word "papillitis" is more specially applied by some. Atrophy is often preceded by optic neuritis occurring in connection with cerebral tumors and inflammations, and in such cases the disk is usually ragged or ill-defined at certain parts; in simple white atrophy, on the other hand, the disk is sharply defined, but this form of atrophy is less characteristic of definite cerebral affections, being found in a variety of conditions. Great changes in the fundus are observed from time to time in the progress of cerebral cases involving the optic nerve and retina; hemorrhages appear and disappear, or give place to patches of exudation. These sometimes become absorbed, or they may increase in number and size. The tendency is for all these inflammatory processes, including even œdema of the papilla, to terminate in atrophy of the nerve.

In attempting to explain the changes in the fundus of the eye, as bearing on medical diagnosis, we must be content with comparatively obscure indications, as the subject has not been sufficiently long under competent observation to lay down general laws safely. The exudations described as characteristic of syphilis, or of Bright's disease, and miliary tubercles, aneurisms, or embolisms (when they can be definitely recognized as such) are sufficiently suggestive of their significance. In addition to the exudations already described, hemorrhagic spots are likewise found in Bright's disease, and the detection of such always demands an examination of the urine; not unfrequently cases of Bright's disease come first under notice from a failure of vision due to these changes. Œdema of the retina likewise occurs in renal dropsy, and its aggravation or subsidence may account for the great changes in the state of the vision which sometimes occur within short intervals. Hemorrhages are found likewise to complicate many inflammatory processes in the optic nerve and retina whether these arise from cerebral or more local affections. They likewise occur in pernicious anæmia, leukæmia, diabetes, and in certain cases of heart disease. In endeavoring to understand the ophthalmoscopic appearances found in connection with cerebral tumors and inflammations, the following different theories may be borne in mind, as they have been advanced to explain the swollen and inflamed state of the optic nerve known as the "choked disk." 1. An interruption to the return of the blood from the eye, due to pressure on the cerebral veins by a tumor, may give rise to congestion and slight fulness of the optic nerve, and there may then be induced a *secondary* increase of this congestion, from strangulation, as it were, of the vessels of the congested and swollen nerve by its own inexpansible sheath. This view is now abandoned by many; the results of constriction are supposed to arise from direct pressure of the inflammatory exudations on the veins. 2. Or, the swelling, congestion, and œdema of the disk may arise from pressure in the subvaginal space, either from the presence of exudation originating there, or from the pressure of fluid forced along the sheath of the optic nerve from the subarachnoid space. 3. An extension of the inflammatory process from the brain or cerebellum, or the membranes, down the course of the optic nerve, may give rise to a "neuritis descendens." This explanation applies specially to cases of meningitis and no doubt also to many cerebral tumors. 4. Vascular changes, resulting in congestion of the optic disk, may be due to disturbances of the circulation, brought about through an indirect influence of the cerebral tumor, or other mischief, on the vasomotor or sympathetic system, apart from any merely mechanical effect, or from any continuity of inflamed tissues.

Optic neuritis or atrophy due to cerebral causes is usually double, although the changes in one eye are often more advanced than in the other; if only one eye be affected, a lesion on the opposite side of the brain may be presumed. Localization of the disease from ophthalmoscopic signs is scarcely possible, but the comparative frequency of blindness and affections of the optic nerve in tumors of the cerebellum is well established. The mere size of the tumor seems to have no relationship to the ocular symptoms. Unilateral optic atrophy (white) is not unfrequent in locomotor ataxy.

THE EAR.

Tests of Hearing. Nervous Deafness.—The sense of hearing is usually tested by means of a watch applied to or held near one ear while the other is closed by the finger. We begin by applying the watch closely enough for it to be distinctly heard, and we gradually remove it, in a straight line from the ear, till the sound is lost; and by measuring this distance we have a means of comparison between the two ears, and also a rough gauge of the absolute acuteness of hearing. The expression in figures may be made thus: if an average ear can hear a given watch at forty inches, and if the patient can only hear it at ten inches with the right ear, but at forty with the left, we write $R. = \frac{10}{40}$: $L. = \frac{40}{40}$: if only audible on contact, we may say $\frac{C}{40}$. In other cases, low speech, or notes of different pitch, at varying distances, or loud sounds, are sometimes tried to test the power of hearing. Some persons hear a watch badly, and conversation pretty well; in others, again, this is reversed.

The degree in which sound is conducted through the bones, when a sounding body is applied directly to the head, sometimes yields valuable information, especially in discriminating deafness due to disease in the nervous structures of the ear, from that due to disease in the conducting apparatus (external and middle ear). When the hearing is normal, "bone conduction" of sound is weaker than "air conduction," which is, of course, the ordinary medium of hearing. (*a*) In the normal state, if a vibrating tuning-fork be held in contact with the mastoid process till the note has completely died away, and then quickly transferred to a point near to, but not touching the orifice of the ear, the sound will be heard for several seconds longer—"Rinne's experiment, positive result." (*b*) In some cases of deafness the sound of the tuning-fork is *not* heard when held opposite the ear after it has ceased to be audible as applied to the mastoid process—"Rinne's experiment, negative result."

In cases of deafness with a "negative result" it is held by Lucae that the disease causing the deafness is in the conducting structures of the ear: if, on the other hand, a "positive result" is obtained, the disease is assumed to be in the nervous apparatus. These deductions from the results of Rinne's experiment are not to be relied on in all cases, according to Politzer and Barr. A more reliable test consists in applying a large vibrating tuning-fork (C) to the middle line of the head (forehead, vertex, or teeth), and ascertaining if it is perceived by the patient principally or exclusively on the side on which he is deaf: or in the event of both eyes being affected, if it is heard more loudly on the deafer side (Weber's test). In either of these cases, it may be assumed, with great probability, that the disease causing the deafness is in the conducting structures: if an opposite result is obtained by this test, a lesion of the nervous structures of the ear may be inferred. The watch is also used in testing "bone conduction." When in a case of marked deafness the tick of the watch applied to the temple or forehead is heard in the deaf ear more loudly than in the hearing ear, or more loudly than if applied to the orifice of the ear, the nervous structures are probably unimpaired. It seems, however, that an opposite result does not, in every case, justify us in assuming disease of the nervous structures.

EXAMINATION OF THE EAR.

When, by means of the watch test, or otherwise, we are satisfied of an impaired state of the hearing, we must examine the organs to see if any impediment can be found, such as a plug of wax, or any growth or tumor in the meatus, or any obstruction in the passage of the Eustachian tubes. The ear is illuminated by reflecting light from a concave mirror through a speculum which straightens and slightly dilates the external meatus. Daylight is much the best, but a lamp may be required when this is defective. If wax be found on such an examination, the hearing should be tested after its removal by syringing, as it does not follow that the wax was the sole or the chief cause of the deafness complained of. Inquiry should likewise be made as to the existence, at any period, of discharges of any kind from the ears (pus, blood, or watery fluid), and in such cases the likelihood of perforation, or even of almost complete destruction of the membrana tympani, must be considered. Fracture of the base of the skull must also be remembered in this connection. This perforation may demand a careful examination of the ear by means of the speculum, as just described, but sometimes it can be demonstrated by causing the patient to force air into his ear by blowing his nose while the nostrils are tightly compressed (Valsalva's method). In many cases of perforation of the membrane, we may, in this way, hear a loud hissing or whistling sound due to the air rushing through the perforation. This same experiment likewise enables us to discover if the Eustachian tube is patent; for when the tympanum is in its natural state we may thus hear, by means of the aurist's diagnostic tube (or even a stethoscope applied to the external ear), a sharp click from the compression of the air in the cavity during the blowing of the nose as described. This method is not available in children, or in those adults who cannot be made to do the experiment properly. Politzer's bag, with its tube introduced into the nostril, is often useful in such cases, as the air can be thus blown through the Eustachian tube during the act of swallowing, when no obstruction is present. In other cases, again, the proper investigation requires the air to be actually blown into the Eustachian tube by an ear-catheter introduced into it, but such manipulations are only to be attempted by those specially trained in aural surgery. In examining the Eustachian tubes attention should be directed to the condition of the pharynx, tonsils, and posterior nares, as many aural diseases begin in these situations. A proper examination of the orifices of the Eustachian tubes may demand the use of rhinoscopy. (See Chapter X.)

In the examination of the ear by the speculum and reflected light, we aim at discovering the condition of the walls of the meatus, the appearance of the membrana tympani, whether it is ruptured, or whether distinct alterations exist in the curvature of the membrane—such as bulging toward the meatus or the contrary—whether there is any abnormality in the reflection of the light from the membrane, and whether there is undue vascularity in the neighborhood of the handle of the malleus or elsewhere. An exploration of the state of the petrous bone, in cases of suppuration, can sometimes be made by means of the probe, although this is a dangerous instrument in such situations. All these changes point to disease of the meatus and middle ear, and they indicate mechanical causes for the deafness, and so may remove it from the realm of the physician. But suppuration in the tympanum, etc., may throw a light of the utmost value on certain cerebral or pyæmic symptoms in a case. Abscess of the brain and meningitis occasionally depend on some previous suppuration in the ear, and this may have extended upward from the throat, as in certain cases of scarlatina. Puffiness over the mastoid process, generally with present or past otorrhœa, is sometimes found in connection with suppuration going on in the mastoid cells, and this suppuration may be associated with a train of symptoms indicative of septic poisoning or other serious mischief, to which it may supply the only clew. Facial paralysis is not unfrequently due to disease of the middle ear, especially when this is of a suppurative character. When a degree of deafness exists, and its cause cannot be referred to any impediment in the passages of the ear, we may infer a lesion of the auditory nerve in some part of its course; the test by bone conduction may greatly assist us, and an examination of the other cranial nerves may throw some light on the nature and position of the lesion; the presence of subjective symptoms must likewise be considered in this connection. The occupation of the patient, and his relation in this respect to noises, the previous history of blows on the head, of attacks of giddiness, or of noises in the ears, and the family history as to deafness, hereditary syphilis, etc., should all be inquired into. Scarlatina, typhus, and typhoid fever are often complicated with deafness during the acute illness, and this occurs occasionally as a sequela: in the first-named disease the mischief is usually in the conducting structures of the ear, in the others the deafness is almost always nervous.

Noises in the ear (tinnitus aurium) are often complained of: they are generally associated with some degree of deafness, more rarely with no defect in hearing. The noises vary in degree from very slight sounds, heard only when everything around is perfectly still, up to noises so distressing as scarcely to be bearable. The sounds are described in the most varied manner as ringing, humming, hissing, buzzing, whiffing, etc. Sometimes there are two or more different kinds of sound in the one ear. They are often traceable to some mechanical cause, giving rise to pressure on the labyrinth, either directly or indirectly. Thus wax pressing on the membrana tympani, or obstructions in the Eustachian tube altering the pressure of the air in the tympanum, can sometimes be shown (by the effect of their removal) to have been the cause of tinnitus.

It should be remembered, however, that apparently similar obstructions may exist without producing this symptom. In cases of deafness, brought on by blows on the head, tinnitus is often present. In many cases the noises in the ear seem to be due to actual mischief in the labyrinth itself, and especially to pressure of the stapes on the foramen ovale; such pressure may arise from disease of the external, middle, or internal ear. A lesion of the labyrinth is especially probable in those cases where the noises are associated with great deafness, and with sudden and violent attacks of giddiness, and a tendency for the patient to turn or to fall to one side (Ménière's disease. (See p. 290.) Occasionally the noises in the ear appear (like certain forms of deafness) to be purely nervous, coming and going irregularly, or especially produced or aggravated in connection with mental annoyance and over-fatigue; or developed, like certain forms of weak sight, by prolonged lactation, etc. Noises in the ear have, in certain cases, their explanation in disturbances existing in the brain itself, or in its circulation; like flashes of light, they form part of the prodromata of apoplectic attacks. In certain cases of acute diseases (typhus), and in some nervous complaints, the hearing is abnormally acute, so that very slight sounds, otherwise likely to escape notice, seem to be painfully loud, although in other stages of typhus and enteric fever deafness is often present. Quinine in full doses often produces more or less noise or ringing in the ears; great differences exist as to the susceptibility of patients in respect of quinine. Salicine and salicylic acid may also give rise to the same symptom. Sometimes the noise or singing in the ears is due, in all probability, to the patients hearing sounds actually produced in their own blood-vessels, and these can sometimes be stopped for the time by pressure on the carotids. Possibly they sometimes hear sounds produced by the circulation of the blood in the rigid arteries at the base of the brain in cases of atheroma.

A whiffing sound, as if close at the ear, corresponding with the arterial pulsations, is often complained of by persons affected with some disorder of the heart's action (usually of a functional character), and associated with a sense of throbbing throughout the arteries; this sound distresses them chiefly while lying on the left side, and, indeed, often renders this posture in bed impossible.

THE NOSE.

The sense of smell is tested by applying a phial charged with very distinct odors to the nostril; one nostril should be tested at a time, the other being compressed, and the mouth also should be kept shut. If the smell be not appreciated in this way, the mouth may be kept open while the scent is being sniffed up, or strongly flavored materials may be given to be tasted or applied in such a way as to allow the odor to ascend by the posterior nares. The odor may be blown into the mouth and the person directed to breathe out through his nose. The patient may likewise be questioned regarding his recognition of flavors in his food or drink, as it has been clearly ascertained that much of what we discern by the mouth is really due to the sense of smell, and that those who are affected simply with a loss of smell from nervous lesion (anosmia), are incapable of discriminating the flavor of many articles of diet (wines, coffee, cheese); such persons frequently tell us that both smell and taste are nearly gone, and may complain more of the loss of taste, as they call it, than of the loss of smell.

Certain fallacies beset our investigation of this sense. 1. The presence of strongly pungent vapors or solids (ammonia, snuff, etc.) may be recognized by those destitute of smell, from the action of these irritants on the branches of the fifth nerve; such things, therefore, must be avoided as tests; assafœtida, musk, lemon, camphor, etc., are suitable for this purpose. 2. Smell may seem lost from some imperfection in the nasal cavity apart from any nervous lesion; thickening of the mucous membrane from a common cold, or more serious alterations in the hard or soft parts, as well as distinct growths, are frequent sources of imperfection in the sense of smell; in such cases smells may possibly still be appreciated (especially as flavors) by way of the posterior nares; in other cases the nasal affection may have actually impaired the terminal branches of the olfactory nerve in the mucous membrane. 3. In facial paralysis, probably from some difficulty in directing the odorous current forcibly to the olfactory tract, in sniffing it up, there is sometimes an imperfect sense of smell in the paralyzed nostril, without any real defect in the first nerve. A dryness of the nostril may likewise cause a defect in smell, —the tears flowing down the cheek, instead of into the nasal duct in certain cases of facial paralysis. Disorders of the fifth nerve may also produce changes in the state of the mucous membrane, and so impair the acuteness of smell.

Loss of smell, as a single lesion, is sometimes met with in connection with injuries to the head; but in the case of cerebral tumors and the like, other nerves are usually involved, and not the first nerve alone. When anosmia is associated with hemianæsthesia, from cerebral causes, the two are on the same side—that is, on the opposite side from the presumed lesion in the brain. On the other hand, when anosmia is associated with aphasia and gross lesions of the temporo-sphenoidal lobe, the olfactory nerve is implicated on the same side as the cerebral lesion.

Perversions of smell and the associated perversions of taste, as distinguished from a pure loss of these senses, are almost entirely limited to cases of insanity, or other serious affections of the brain and nervous centres, including hysteria. Such perversions are, no doubt, intimately associated with the delusions from which the insane sometimes suffer when they imagine that they are themselves fetid and putrefying, or that they are asked to eat filth, or that attempts are made to poison their food. The occurrence of "a bad smell" constitutes sometimes the aura ushering in an epileptic fit. Occasionally a patient is conscious of a bad smell, really present in his case, say from gangrene of lung or fetid eructations in dyspepsia, when the attendants may have a difficulty in recognizing its presence, because of its only coming occasionally with certain coughs or eructations. The use of certain medicines, as phosphorus and some metallic salts, may likewise produce at times disagreeable sensations in the organs of smell and taste. The use of bismuth may give rise (probably from the presence of an impurity) to an odor of garlic in the breath which may be perceived by the patient and also more commonly by the attendants.

Chronic discharge from the nose is sometimes simply catarrhal, but it is usually fetid (ozæna), and often depends on disease of the bones which can be detected by the probe. Such a discharge in children from *one* nostril only is always suggestive of the presence of a foreign body in the nose. Fetor from the nose may be distinguished from fetor due to gangrene of lung, or from that of sore throat, disordered stomach, carious teeth, etc., by testing the breath while the mouth and the nostrils are closed alternately.

"Running from the nose" is one of the features of coryza or catarrh of the nasal passages and sinuses connected with them; it is a leading feature of a "cold in the head," and also forms a prominent symptom in the invasion of measles. The obstruction to the breathing through the nose observed in infancy, and known as "snuffles," is usually due to syphilis.

THE SENSE OF TASTE.

The sense of taste is not easily tested in a satisfactory manner. The difficulties are the following: Some so-called tastes are really appreciated by the olfactory nerve, while acrid substances may perhaps be recognized by the nerves of common sensation. Loss of taste from nervous causes (ageustia) is very often unilateral, and when a sapid substance is applied to one side of the tongue as a test, it is apt to pass over quickly to the other side, or to the soft palate, when the tongue is taken in. To avoid this, the substance may be applied to the tongue while it is kept protruded, but it is found that even in the normal state it is not easy to recognize various tastes under such conditions. The sense of taste proper seems to reside in the tongue and soft palate chiefly, but the movements of the tongue against the hard palate and lips, and the intimate admixture of the substance with the secretions of the mouth, seem to be almost essential for the proper appreciation of tastes. A further difficulty arises from the different parts of the tongue having very different degrees, and even kinds of sensation. The best way is to try strong solutions of a sweet and of a bitter substance, as these are pure sapids (sugar and picric acid, *e. g.*) and to rub them with the finger or with a piece of lint, or a brush, *very freely and firmly* on to various parts of one side of the tongue while it is protruded, and to ask the patient to indicate by a movement of the head whether and when he recognizes the taste before he takes in his tongue. If we suspect a defect on one side, we can sometimes demonstrate it more clearly by applying the test solution to the affected side, and while it is still unrecognized, we may touch the other side of the tongue with the same substance before it is taken in; we may thus find that the patient at once indicates his recognition of the test fluid on the sound side by a sign or a contortion of his face. Care must be taken to have the patient's mouth thoroughly washed out before any new substance is tried, as also to have the brushes or other agents used in applying the test thoroughly cleansed, and it is well to begin with the milder tastes, as the strong bitter substances linger a long time in the mouth and complicate further trials.

In addition to sweet and bitter, acid and salt substances should be tried. Acids without smell must be selected for such trials, such as citric or tartaric acid. The galvanic test may be applied by means of small electrodes, at the end of fine wires fastened on a handle, but insulated from each other, and connected with a few cells of a constant current battery. This may be used to define the *area* of the gustatory sense in the tongue, as well as to ascertain its presence. Along with the tests by sapids, the tongue should also be tried as to its tactile sense by the compasses (see pp. 196–199); loss of taste with perfect tactile sensation, and loss of tactile sense with perfect taste, are both occasionally found, as well as loss of both; we must also, of course, pursue the examination by testing the other cranial nerves, etc. The significance of a lesion of taste, when ascertained, is rendered somewhat obscure by the curious differences of opinion as to the nerves of taste and their real origin. The glosso-pharyngeal, for special sense at the back part of the tongue, is generally recognized; Dr. Gowers, however, thinks that this nerve has really nothing to do with taste, although fibres from the fifth nerve may be distributed along with its terminal branches, and so give rise to this idea. The lingual branch of the fifth nerve is admitted by all to supply common sensation to the tongue, and most authorities consider it to be concerned more or less also in the special gustatory sense; the chorda tympani nerve, however, which joins it from the seventh, is now regarded as the nerve of special sense for the anterior part of the tongue, and it seems quite certain that it has to do with the sense of taste. But admitting this as proved, it is not quite certain that the portio dura of the seventh pair really contains in itself sensory fibres; some, indeed, allege that the sensory fibres in the chorda tympani come from the "pars intermedia" of the seventh pair, or from some junction with the fifth nerve in ways which are not always uniform. It is conceivable, moreover, that the lingual and chorda tympani may affect the sense of taste by an indirect action on the glands and papillæ. We may regard it as certain that taste may be affected in cases presenting evidence of a lesion in the glosso-pharyngeal nerve; that it may be affected, or preserved, in cases presenting definite disorders of the fifth nerve, including among these anæsthesia of the tongue; and that it is often affected in cases presenting the well known features of paralysis of the portio dura of the seventh pair, arising from disease of the ear and other peripheral causes. The variation as to the presence of the affection of taste in cases of facial paralysis depends probably on the exact locality at which the lesion of the seventh nerve exists; when this paralysis is due to a cerebral lesion, the taste does not appear to be affected.

The taste may also be affected in various ways in general diseases, such as insanity and hysteria, and the perversions of taste, like those of smell, referred to under that sense, may be mixed up with the delusions and hallucinations of the insane. In various forms of digestive disorder the patients often complain of having "a bad taste" in the mouth. Local causes affecting the tongue, such as dryness in febrile disease, foul coating in dyspepsia, stomatitis, and the like, naturally impair the sense of taste.

SENSIBILITY OF THE SKIN AND MUSCLES.

The skin has various forms of sensibility which are, so far, capable of differentiation, and as these are variously affected in disease, different tests come to be applied. In carrying out any of the following tests in cases of nervous disease, a certain *slowness in the transmission of the sensations* may be noticed, or there may be a second and different kind of sensation transmitted after the first impression.

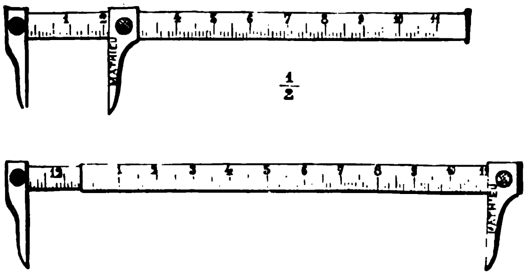
Common Sensation. Analgesia.—The most marked differences in disease are presented by the tactile sense and the sense of pain: what would be felt in health as extremely painful may be felt distinctly enough, but quite without pain: in such cases even the slightest touch may be perceived as acutely as in health.

The sense of pain belongs to the group of "common sensations," as distinguished from more specialized sensations, and may here be taken as their type. Itching, burning, and other conditions bordering on pain are included in this group: but pleasurable sensations come also under this category. The sensation of electrization of the skin comes under it, and as the current from an induction apparatus can be regulated to produce the slightest perceptible effect, or the most painful sensations, it is reckoned the best test. The electrodes of a faradic battery are applied close together to the part, by preference in the form of a fine wire brush; the minimum strength which can be perceived is noted as well as the maximum strength which can be borne without a sense of pain. We may find that the patient perceives the application of a strong current in the affected area, as if the brush were touching him, with, however, no sense of pain, but at once cries out when the brush is taken beyond the boundary of the affected part. In the same way a needle thrust through the skin and twisted about may be perceived by the patient, but without pain, apparently much in the same way as any one might feel the same process applied to the sleeve of his coat. This loss of the sense of pain, with preservation of the tactile sense, is termed *analgesia*.

The sense of temperature seems also to be so far distinct from other forms of cutaneous sensibility. It is best tested by means of hot and cold water, in two similar test tubes, applied to the skin. The patient is then asked to say which of the tubes is the hotter. By varying the temperature of the water an exact estimate of the delicacy of this sense can be arrived at. A hot and cold spoon serves the purpose of a rough test. At times temperatures may be felt as painful although they are not extreme. This indicates a hyperæsthesia or excessive sensibility: allied to this is the tenderness experienced in some forms of spinal inflammation on applying a hot sponge to certain of the vertebræ.

The tactile sense is very unequally distributed over the cutaneous and mucous surfaces, some parts being very much more sensitive than others. Defects in the acuteness of this sense are often complained of in particular parts, and so it becomes important not only to verify the existence of this anæsthesia, but also to define with some accuracy its degree and its distribution. Various methods are pursued. The patient may be touched lightly with the finger or a feather in various parts, and he should be asked, while his eyes are shut, whether and at what part he is touched, the observations being, of course, varied by an occasional blank experiment. A source of confusion consists in the transmission of vibrations mechanically from the region of one nerve distribution to that of another; so that in a finger whose supply is wholly lost a rubbing sensation may be felt by contiguity, much in the same way as one can feel something rubbing the surface of his glove and can even define the direction of the movement. It is found that in anæsthesia the precision of localizing the sense of impact is much diminished. If the defect be very slight the patient may be tried with the most delicate impressions possible, such as result from touching of a hair; if, on the other hand, the sense be very dull, the point of a pin, or the pinching of the skin, may be used to produce a distinct impression, and by the patient's answers, or the expression of his face, we may be able to define the area of impaired sensation. In conducting such experiments it should be noticed if the perception of the impact is distinctly delayed, as this indicates a bluntness in the sense. Other methods of testing the sensation consist in trying if the patient can recognize by the hand, and with his eyes shut, different textures of cloth, flannel from cotton, for example, or if he can say whether a carpet, or a rough or smooth substance, is interposed between his bare foot and the floor, care being taken that there is no great difference in the temperature of these objects. The lifting of minute objects by the hand, the discrimination of coins, and the manipulation of worsted or cotton yarn in sewing or knitting, often enable us to judge of the degree of tactile sense remaining with considerable certainty; blindfolding the patients often brings out very prominently the loss of tactile sense, as we may see them groping about with their hands for objects which are already actually touching their fingers. These methods, or at least some of them, are applicable to various ages and various grades of intelligence, but a greater precision is sometimes obtainable by means of compasses or an "æsthesiometer," as it is sometimes called. (See Fig. 33.)

FIG. 33.



Two forms of æsthesiometer, half actual size. The figures indicate centimetres: the second instrument is adapted for greater separation of the points.

It is found that in anæsthesia the *sense of locality* as regards the part touched varies much, and a patient can often say with certainty that he is touched and yet be very vague as to the locality. This forms the basis of the test (Weber's). A person with a very dulled sense could tell if touched simultaneously on the knee and the foot; but even a healthy subject becomes confused if the two localities touched are sufficiently approximated. The essence of the test, therefore, consists in discovering the smallest distance at which the two points of a pair of compasses, simultaneously and lightly applied to the surface, can be recognized by the skin touched as two separate objects. The points should be blunted in some way (except, perhaps, in the case of the finger-tips and other sensitive parts); sealing wax or ivory points serve this purpose, or the points themselves may be rubbed down. The patient should first be informed, with his eyes open, as to the process of testing to be attempted, a few trials being made to let him know the object aimed at. The eyes should then be shut, or the vision obstructed in some way, and the compasses, widely opened, applied so as to give a distinct impression of two separate points: the points should then be gradually approximated till they are felt as if they made only one impact, or till the answers become confused and unreliable, in which case we may revert after a time to the same part to see if the same result is obtained. During this gradual approximation of the points of the compasses, an occasional variation by the impact of only one limb of the compasses should be introduced, so as to make sure that the patient is not answering at random.

The following directions should be attended to: 1. The two points must be put down simultaneously and with equal pressure, otherwise the *succession* of the impacts leads of itself to the inference of two points. 2. The part of the patient under observation should be kept quite unmoved and steady: patients instinctively, when in doubt, tend to move the fingers or hand to satisfy themselves when asked whether two points are applied, as they get in this way also a succession of impressions. 3. The two points should be always kept in the same relative direction in making estimates of the delicacy of sensation in the same limb—*i. e.*,we must keep always either in the axis of the limb or always transversely to it. 4. The points should be kept stationary, or if moved along allowance must be made for the variation of the sensibility thus introduced, especially if we approach more sensitive areas. With every care the results are often unsatisfactory and confusing. In fact, considerable intelligence is required in the patients to secure reliable results, and they often seem so stupid or careless or fatigued that the results appear a mass of confusion. Possibly at times the disease itself helps the confusion by leading a patient to feel one point as if it were two or more (*polyæsthesia*).

The following list may serve as an indication of the normal sensitiveness of different parts, but it cannot be regarded as absolute: a comparison of the sensation on the two sides of the body indicates changes in a more reliable manner when the lesion is unilateral. (Selected from Weber's table.)

DISTANCES AT WHICH TWO POINTS CAN BE RECOGNIZED AS SUCH IN THE NORMAL STATE.

Point of the tongue	½ line.	Red surface of lips	2 lines.
Dorsum and edge of tongue	4 lines.	Lips where covered with skin	4 "
Palmar surface of third phalanx	1 line.	Dorsal surface of third phalanx	3 "
Palmar surface of second phalanx	2 lines.	Dorsal surface of first phalanx	7 "
Palmar surface of metacarpus	3 "	Dorsum of hand at knuckles	8 "
Skin of cheek	3 "	Middle of thigh	30 "
Tip of the nose	3 "	Over patella	16 "
Lower part of forehead	10 "	Dorsum of foot near toes	18 "
Neck under jaw	15 "	Penis	18 "
Skin beneath occiput	24 "	Upper dorsal vertebræ	24 "
Sternum	20 "	Middle dorsal vertebræ	30 "

The area of diminished sensation, or of complete anæsthesia, often enables us to refer the defect to a single nerve, or to a special branch of a nerve.[1] The extent of the area of anæsthesia, and its level in the trunk, may enable us to define the locality of the lesion in the spinal cord to which it is due. Anæsthesia is, indeed, very often due to spinal lesions, but is sometimes found in more general diseases—after diphtheria, for example (in the skin as well as in the fauces), in hysteria, and occasionally in other affections clearly of a functional character. In cases of ovarian irritation certain limited areas of anæsthesia can sometimes be made out: occasionally the anæsthesia in such cases extends to one side of the body (hemianæsthesia): such unilateral anæsthesia is found also in some cases of cerebral lesions (posterior part of internal capsule), associated with paralysis of the same parts. In locomotor ataxy anæsthesia of the feet and legs is very common. (Compare section on "Paralysis with Anæsthesia," p. 210.) Anæsthesia is frequently caused by pressure on the nerves, as by tight bandages, splints, crutches, etc., or by more serious forms of pressure arising from malignant tumors, aneurisms, abscesses, etc.

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[1] In studying this distribution, Flower's Diagrams of the Nerves, 3d ed., Lond., 1880; and Heiberg's Atlas of the Cutaneous Nerve Supply: Baillière, Tindall & Cox, Lond., 1885, may be consulted with advantage.

The trophic effects of nervous lesions must be noted, when present, as important facts in cases of anæsthesia: ulcerations of the cornea in the case of the fifth, glazing of the skin, wasting of the nails, grayness of the hair, and the like, are to be named in this connection. Anæsthesia can occasionally be shown to exist in an area affected with neuralgia, and a certain degree of anæsthesia—a dulled perception of tactile impressions—is habitually present in cases of so-called hyperæsthesia in which slight irritations of the skin produce painful impressions. In serious lesions of nerves from injury, there is sometimes a deep-seated burning pain to which the name "causalgia" is applied.

Diminution of the sensation in the mucous membranes can be ascertained by touching the parts, tickling the fauces, etc.; diminished sensitiveness of the fauces, epiglottis, etc., sometimes determines the occurrence of choking or of pulmonary affections, especially in the insane. The tongue has already been referred to.

The sense of pressure differs from the sense of touch and the sense of weight. It is tested by applying a series of coins or weights on the part to be tried: this must be firmly supported and care must be taken to avoid complications from the sense of temperature by introducing some non-conducting substance next the skin.

Muscular Sensibility. Sense of Weight.—The "muscular sense" is a name applied by some to the faculty we possess of judging of weight. This faculty is often very defective in locomotor ataxy, and has been supposed to account for the incoördination of the movements found in this disease. In the case of the upper limbs various weights, of as nearly as possible the same bulk, may be given as tests while the patient's eyes are closed, and it can then be seen how far he is able to discriminate them by his muscular sense. For light objects, coins answer admirably—a sovereign and a shilling, for example. In testing the lower limbs the patient may be placed on a high seat, with his feet quite off the ground, or one leg may be swung over the other, and various weights, enclosed in a bag, or attached by any other convenient arrangement, may be suspended on the foot, and the power he has of estimating weights may thus be gauged.

In health there is a distinct consciousness of muscular contraction when it is excited by the faradic current: the sensibility of muscle is tested in this way. Probably connected with the muscular sense, and the consciousness of the outgoing current from the brain to the muscles, is the notion we have of the position in which our limbs happen to be at a given time. The conception of this is often quite erroneous in patients whose tactile sense seems good. The patient's eyes being bandaged, the limbs are placed or held in various positions, and the interrogation made.

Diminution and perversion of the cutaneous sensibility as complained of by the patients may take a great variety of forms.

Anæsthesia is described by patients as a "numbness" or "deadness" of the affected parts, or occasionally as if thickened skin, leather, India-rubber, or even air cushions were interposed between their feet, or other affected parts, and the objects touched. These sensations may be regarded as due to pure defects. Associated with anæsthesia, there may be in the same part "*hyperæsthesia*"—that is to say, painful sensations from irritations which in the normal state would scarcely be noticed: thus a light touch affecting, perhaps, only the hairs of the skin, or a slight current of air, may be felt by such patients as acutely painful; but as there is in hyperæsthesia no real increase of delicacy in touch, but almost always a diminution, the term "*hyperalgesia*" might be more fitly employed, while this, and all forms of disordered sensation, might be classified under the general name of the *paræsthesiæ.* The feeling of "pins and needles" in a limb is often complained of in paralysis; the feeling is somewhat similar to that experienced by everyone at times when by accident undue pressure is made on certain parts of a limb, as on the arm by lying on it, etc. Allied to this tingling is the feeling as if small insects were crawling over the body ("*formication*"); other creeping feelings, and sensations as if the hairs of the body were standing on end (*horripilation*, goose-skin), are complained of in various nervous affections, and also in febrile disturbances. *Feelings of flushing*, both local and general, and *of coldness*, or of cold water trickling down a part, are often experienced in nervous affections, especially hysteria and hypochondriasis, as well as in certain febrile states. (See "Pyrexia," p. 103.) *Coldness of the limbs* is often bitterly complained of in paralysis, although the parts may seem only slightly colder than natural. The *girdle sensation*, a feeling of constriction of the trunk, as if the clothes were too tightly fastened round the body, or as if a cord were tightly compressing it, is often present in spinal affections. Some of the above perverted sensations pass into, or are associated with actual pain in various parts.

TESTING OF THE CRANIAL NERVES.

In many cases of paralysis the critical examination of the cranial nerves may enable us not only to pronounce on the cerebral nature of the illness, but even to localize the lesion in some part of the brain. In certain cerebral affections, moreover, it occasionally happens that only one or two nerves are paralyzed, and these may escape attention unless we test the nerves systematically: variations in the paralysis likewise occur from time to time, in certain cases of cerebral or cranial tumors, and even a more transient paralysis of these nerves is sometimes seen in cerebral abscess.

First nerve—olfactory—supplies the sense of smell. (See p. 191.)

Second nerve—Optic—the nerve of vision. (See p. 178.)

Third nerve—Motor oculi—supplies directly, or through the lenticular ganglion, the sphincter muscle of the iris, the ciliary muscle regulating the accommodation, the levator palpebræ, and all the muscles of the eyeball except the superior oblique and external rectus. These muscles should be tested separately. (See pp. 161–174.)

Fourth nerve—Patheticus, Trochlearis—supplies the superior oblique muscle of the eye. (See pp. 165, 166.)

Fifth nerve—Trifacial, Trigeminal—is partly motor, but much the larger part is purely sensory. The *motor branches* are derived from the small root of the nerve. These motor branches are all given off from the inferior maxillary portion. They are distributed chiefly to the muscles of mastication, viz, the temporal, masseter, and internal and external pterygoids; the mylo-hyoid, and the anterior belly of the digastric, likewise, are supplied from this source. The power of closing the jaw perfectly, and of moving it laterally, affords evidence of the soundness of these branches. The buccinator muscle was formerly supposed to be supplied by the fifth, but it is now recognized that the buccal branch of this nerve is sensory, and that the motor supply comes from the seventh. The motor branches from Meckel's ganglion going to the palate and uvula are supposed to be derived from the seventh nerve.

The *sensory branches* supply common tactile sensation to the skin of the face from the forehead to the chin, to the mucous surfaces of the mouth, tongue, palate, and uvula; the conjunctiva, the mucous membrane of nose and the teeth, are all supplied from this source. In addition, the lingual or gustatory branch supplies probably some portion of the special sense of the tongue (apart even from the fibres of the chorda tympani nerve mechanically united with it). The fifth nerve has, however, very important functions connected with the nutrition of the eyeball, of the hairs, and other parts to which it is supplied. When affected as far back as the Gasserian ganglion, sloughing of the cornea, and other trophic changes have been observed. The tests applied in judging of the sensory branches of this nerve are by means of the compasses for the common tactile sense of the skin, tongue, and lips; by tickling the palate or uvula for the production of reflex action, acting on one side only at a time; by test solutions for the special sense of the tongue (see "Taste," p. 193); and by examination of the clearness of the cornea, the color of the eyebrows, the amount and character of the secretions of the nostrils, etc., for any trophic changes in affections of this nerve. Pain or neuralgia in the situations enumerated above may be referred to this nerve.

Sixth nerve—Abducens oculi—supplies only the external rectus of the eye. Deficiency in the power to move the eyeball outward is the sign of paralysis of this nerve, but care must be taken to ascertain that the eyeball is not fixed from inflammation, abscess, or tumor of the orbit. In slighter forms, diplopia may be the only evidence of this paralysis, while in severer forms there may be internal strabismus. (See pp. 161, 169.)

Seventh nerve (portio dura)—Facial—This nerve is essentially motor, but some communicating branches are still involved in doubt as to their exact function. The muscles directly supplied include all the great muscles of expression, and in judging of their healthy or paralyzed condition, it is desirable to get the patient to laugh, to whistle, or to simulate expressions of surprise, etc. These muscles include those of the external ear, the occipito-frontalis, corrugator supercilii, orbicularis palpebrarum, the muscles of the nose, cheek, upper and lower lips, the orbicularis oris, buccinator, stylo-hyoid, part of the platysma, and the posterior belly of the digastric. In addition to these, the facial sends a branch to Meckel's ganglion—the large superficial petrosal nerve—and it is probably from this source that the motor supply of the azygos uvulæ and the levator palati is derived. The facial, moreover, sends a branch—the chorda tympani—to join the lingual or gustatory of the fifth; and it is now generally agreed that the chorda tympani supplies the sense of taste in the anterior part of the tongue. (See "Taste," p. 194.) The facial also supplies the intrinsic muscles of the tongue (lingualis).

In examining cases of paralysis of the portio dura, attention should be specially directed to the occipito-frontalis and the orbicularis palpebrarum: these are usually paralyzed to a marked extent in lesions affecting the trunk of the nerve. The eye often remains uncovered and waters readily, or even becomes seriously affected from exposure. In slighter forms of paralysis of the orbicularis the inability to close the eyelids may only become obvious when the patient is asked to shut each eye separately. These muscles often escape in large part in the facial paralysis due to general cerebral causes (hemiplegia). The mouth is usually also badly affected in lesions in the trunk of the seventh, so that the patient cannot whistle, and from paralysis of the orbicularis oris the saliva may escape: from the flabby state of the buccinator, the food often accumulates helplessly between the cheek and the teeth. All these symptoms are usually much more marked in cases of paralysis from peripheral causes than in those from central affections. Deviation of the uvula or unilateral paralysis of the palate sometimes leads to a diagnosis of a lesion behind the origin of the petrosal branch in the tympanum (the nervus petrosus superficialis major arises at the intumescentia gangliformis). The palate hangs loosely on the paralyzed side, and its reflex movements are lessened: it may also be drawn to the sound side. The uvula sometimes deviates to the paralyzed side, sometimes to the sound side. It is not always quite even in the healthy state, and this probably accounts for its being off the middle line in some of the cases of paralysis reported; but its deviation to the paralyzed side has been attributed by some to the unopposed action of the pharyngopalatine muscle. Paralysis of the seventh nerve may affect the movements of the tip of the tongue, especially the pointing of it or the moving of the tip in various directions when protruded. It is also quite certain that some loss of taste occasionally exists in the anterior part of the tongue in peripheral paralysis of the facial nerve. The hearing should be tested carefully in paralysis of the portio dura.

The passage of the facial nerve through bony canals renders it very liable to injurious pressure from inflammatory exudations, especially of the rheumatic and syphilitic type; in young subjects the nerve is occasionally unprotected by bone in the tympanic cavity, and so inflammatory processes there also may lead to temporary compression, even when no destructive lesion in the bone has been produced.

Facial paralysis sometimes exists on both sides (bilateral or double facial paralysis). In such cases the face is symmetrical but expressionless. It may arise from a combination of right and left aural disease, or from accidental combinations of other peripheral forms of facial paralysis. It is most commonly, however, due to disease in the pons Varolii or medulla oblongata, and constitutes in this way a feature of progressive bulbar paralysis. (Glosso-labio-laryngeal paralysis.)

Seventh nerve (portio mollis)—Auditory. This nerve supplies the sense of hearing: it has been also supposed to be concerned in the estimate we form of our position in space, and so in the power of maintaining our equilibrium. Disorders in it show themselves by deafness, noises in the ear, and it may be vertigo. (See p. 190.)

Eighth nerve—glosso-pharyngeal—is almost purely sensory: it supplies sensation to the tonsils and pharynx, and so is greatly concerned in the reflex actions of swallowing: it supplies the back part and the sides of the tongue with special sensation, and is distributed to the circumvallate papillæ. It supplies the mucous membrane of the tympanum and Eustachian tube with sensory fibres. It may be tested by attempting to produce reflex actions, by tickling the pharynx, and by test solutions, especially bitter fluids, applied to the back of the tongue. (See "Taste," page 193.)

Eighth nerve—spinal accessory. The portion of the nerve which arises from the medulla oblongata (bulbar portion) seems to be distinct in function from that arising from the spinal cord. Both roots are purely motor. The fibres from the bulbar portion enter the branch communicating with the pneumogastric, and are distributed to the muscles of the pharynx and larynx (through the superior and recurrent laryngeal nerves). The fibres derived from the spinal portion of the nerve are distributed to the sterno-mastoid and trapezius muscles. Disorder of the roots of the spinal accessory nerve may, therefore, give rise to laryngeal and pharyngeal disorders, or to convulsive or other affections of the trapezius or sterno-mastoid.

Laryngeal disorders may also arise from affections of the recurrent laryngeal nerve, due to aneurismal or other tumors in the chest. Glosso-labio-laryngeal paralysis is probably associated with, and in part due to, an affection of this nerve.

Eighth nerve—pneumogastric. This nerve has such a wide distribution, such important connections with other nerves, especially the sympathetic, and still remains in so much obscurity as to certain of its functions, that no attempt need here be made to detail its sphere of operation. The student may remember, in the present connection, that it supplies the mucous membrane of the pharynx and larynx, and also the muscles of both, although, as mentioned in the preceding section, this motor portion is derived probably from the spinal accessory. The thyroid gland also derives its supply from the pneumogastric; and the heart, lungs, œsophagus, stomach, bowels, liver, and spleen all receive important nervous filaments, either directly from this nerve, or from the cardiac, pulmonary, and other plexuses to which it gives branches. Aphonia, dysphagia, vomiting, constipation, palpitation, intermittent pulse, hepatic disorder, glycosuria, diabetes, and respiratory disorders and distress, may all at times be referred, directly or indirectly, and with more or less probability, to an affection of this nerve in some part of its course.

Ninth nerve—hypoglossal—is purely motor. It supplies all the depressor muscles of the hyoid bone, receiving some important fibres from the second and third cervical nerves through the communicans noni. The genio-hyoid and the omo-hyoid are also supplied from the same source. It also supplies the (extrinsic) muscles which act on the tongue, and it even gives a few terminal fibres to its intrinsic muscles (lingualis). This nerve, therefore, is concerned in deglutition and in the movements of the tongue. Paralysis of this nerve on one side leads to protrusion of the tongue *toward* the paralyzed side, from the unopposed action of the sound genio-hyoglossus. If extreme, as in cases of injury, the paralyzed side is flabby and falls into wrinkles, but there is no loss of tactile or gustatory sense. The tongue is usually deviated to one side from affection of this nerve in hemiplegia; in glosso-labio-laryngeal (bulbar) paralysis the ninth nerves are clearly involved.

The subjects comprised under this chapter are discussed in many of the works on nervous diseases referred to in the next chapter, such as —Ross, The Diseases of the Nervous System, 2d edit., 2 vols., London, 1883.—Gowers, Diagnosis of Diseases of the Brain, London, 1885. —Physiological works may also be consulted—*e. g.*, Landois, Text-book of Human Physiology, translated by Dr. Stirling, 2 vols., London, 1885; and Austin Flint, Jr., The Physiology of Man, 5 vols., New York, 1868–74; the fifth volume deals with the special senses.—Anatomical works are also useful for reference, especially such works

as—Flower, Diagrams of the Nerves, 3d edit., London, 1880.—Heiberg's, Atlas of the Cutaneous Nerve-supply of the Human Body, translated by W. W. Wagstaffe, London, 1885.—Rüdinger, Anatomie der Menschlichen Gehirn-Nerven, 2d edit., Stuttgart, 1870.

Eye.—In addition to general treatises on ophthalmic medicine, the student is referred to the following: Robin (Albert), Des Troubles Oculaires dans les Maladies de l'Encéphale, Paris, 1880.—Gowers, Manual and Atlas of Medical Ophthalmoscopy, 2d edit., London, 1882.—Panas, Leçons sur le Strabisme, les Paralysies Oculaires, le Nystagmus, le Blepharospasme, etc., Paris, 1873.—Wecker et Jäger, Traité des Maladies du fond de l'Œil, et Atlas d'Ophthalmoscopie, Paris, 1870.—Bouchut, Atlas d'Ophthalmoscopie et de Cérébroscopie, Paris, 1876.

Ear.—Politzer, Text-book of the Diseases of the Ear and adjacent Organs, translated by Dr. Cassells, London, 1883.—Barr, Manual of Diseases of the Ear, Glasgow, 1884.—Macnaughton Jones, Atlas of Diseases of the Membrana Tympani, London, 1878.—Hinton, Atlas of Diseases of the Ear, London, 1874.—Woakes, On Deafness, Giddiness, and Noises of the Head, London, 1879.

Nose.—In addition to general surgical treatises, special treatises on diseases of the throat and of the ear deal with this region—*e. g.*, Prosser James, Laryngoscopy and Rhinoscopy: the Diagnosis and Treatment of Diseases of the Throat and Nose, 4th edit., London, 1885.—Mackenzie (Morell), Manual of Diseases of the Throat and Nose, 2 vols., London, 1884.—Woakes, Post-Nasal Catarrh and Diseases of the Nose, London, 1884.—Ogle (W.), Anosmia: or, Cases Illustrating the Physiology and Pathology of the Sense of Smell, Medico-Chirurgical Transactions, vol. liii, London, 1870.

CHAPTER VI.

SYMPTOMS OF DISORDER IN THE NERVOUS SYSTEM.

VARIOUS symptoms of disorder in the nervous system have been already dealt with in the chapter on the "Organs of Special Sense and the Cranial Nerves" (Chapter V.): and in two subsequent chapters special branches of the subject will be taken up in connection with the employment of "Electrical Instruments in Diagnosis" (Chapter VII.): and the "Study of Insanity" (Chapter VIII.). These sections must, therefore, be referred to as supplementing the present chapter.

PARALYSIS.

Paralysis is usually understood to mean a loss or diminution of motor power: occasionally the term is applied to sensory as well as motor nerves, in which case some loss of function is signified.

The distribution of the paralysis is one of the first points to be investigated. "Hemiplegia" is the name given to a paralysis of one lateral half of the body, especially of one arm, one leg, and one half of the face; the paralysis of the face is usually on the same side as that of the limbs; when it is on the opposite side it is termed "alternate hemiplegia," or "crossed paralysis." "Paraplegia" technically denotes a paralysis of the lower part of the body; the legs and the lower part of the trunk, including at times the bladder and rectum, are the parts affected. "Monoplegia" is a term applied to paralysis of one limb.

Paralysis is sometimes limited to the lower limbs or even to the parts below the knee, to the hands, arms, and shoulders, or to the forearms (especially in cases of infantile paralysis, wasting palsy, lead poisoning, and traumatic paralysis). Paralysis of the face often exists without any affection of the limbs; it is usually one-sided, but occasionally double.

Beyond these obvious distinctions we must be on the watch for more definite anatomical and physiological variations in the distribution of the paralysis; thus we have affections of single nerves (as the sixth), or of special divisions of a nerve, as in the case of the third cranial nerve (see pp. 160–174), or of the musculo-spiral nerve and the like. Or we may have special muscles or groups of muscles paralyzed, as in the case of the deltoid, and the muscles of the thumb in muscular atrophy; and of the extensors of the forearm, with the immunity of the supinator longus, in lead paralysis. Again, the distribution of the paralysis may affect special processes, as in paralysis of deglutition, articulation, respiration, etc ,—various nerves and muscles being implicated together.

The delicate exercise and coördination of the movements required in the complex use of the vocal organs, of the hand in writing, and of the feet and legs in walking, may be greatly impaired in cases where paralysis, in its ordinary sense of want of motor power, can scarcely be affirmed. Such a condition is observed in the early stages of locomotor ataxy, general paralysis of the insane, writer's cramp, shaking palsy, and some other affections.

The state of the patient as to intelligence, and his general mental and emotional condition, are to be noticed particularly in the examination; they are likewise to be considered in connection with the previous history of such paralytic attacks. This inquiry is of special weight in cases of hemiplegia, of paralysis of the cranial nerves, of shaking palsy, and of general paralysis of the insane. It is evident, also, that we must ascertain how far the mental condition of our patient can be relied on before we submit him to tests, the value of which turns largely on his intelligent coöperation. We seek to know if any period of unconsciousness occurred in connection with the paralysis, and at what stage of the illness it supervened; what warning was given of the attack by headache, sickness, giddiness, or the like; what was the depth of the unconsciousness and the period of its duration; whether it was associated with convulsions, and of what kind these were; whether the unconsciousness has passed away or still continues to any extent. (For observing paralysis in unconscious states, see "Fits: Sudden Paralysis," p. 251.) We have often to inquire, moreover, whether the intelligence was affected in any degree, before the paralytic attack, or during its onset, or only after its continuance for some time. We must test the intelligence, by questioning the patient on subjects with which he is known to have been familiar, or we may have to take the opinion of his friends on this point.

Associated with more or less diminution of the intelligence, and occasionally without any indication of weakness in this respect, we observe in some forms of paralysis an excessive mobility of the emotional nature, manifesting itself in some patients by weeping, and in others by laughing without any adequate cause; in some there are alternations of both conditions. In general paralysis of the insane we often have in the patient inflated ideas of his general importance, and even of his strength; in cerebro-spinal sclerosis there is usually a striking placidity of mind and general hopefulness as to his condition, but this peculiarity does not go much beyond this limit. Irritability of the temper, and very great changes in the moral character, not unfrequently date from paralytic attacks.

The sensations of the skin are often affected—sometimes impaired and sometimes perverted. (For "Anæsthesia and Perverted Sensations," see pp. 195–201.) When sensation is intact, this should be mentioned. When an affection of the sensibility can be determined, this should be defined as to its distribution, and compared with the distribution of the paralysis; in some regions, as in the case of the abdomen, we are able to form a more accurate notion of the level of a spinal lesion by considering the range of the anæsthesia than by merely considering the range of the paralysis. When this affection is limited to one lateral half of the body, it is termed "hemi-anæsthesia;" this is comparatively a rare occurrence in hemiplegia, at least in a glaring form; when due to cerebral disease, it is supposed to point to a lesion in the posterior part of the internal capsule. It may exist quite apart from paralysis, and frequently there is no gross lesion at all in such cases, the symptom changing from side to side. It is then regarded as hysterical; it is often associated with hemiopia. (See pp. 180 and 199.)

The limitation of anæsthesia to the area supplied by a particular nerve, as in the case of the fifth nerve, is of great diagnostic value; this may concur with paralysis of the muscles of mastication supplied by the same nerve. Similar combinations of anæsthesia and paralysis, in the regions supplied by special nerves, nerve trunks, or plexuses, may be seen in various affections, especially in traumatic cases, and, as already mentioned, in serious lesions of the cord. In estimating the site of the lesion in the cord, a comparison of the distribution of the anæsthesia with the spinal origin of the nerves implicated, can be readily made by the use of Flower's diagrams of the nerves.[1]

Paralysis often exists to a marked extent without anæsthesia, or with little alteration as regards sensation. In ordinary hemiplegia, well-marked anæsthesia is rare. Even in many cases of paraplegia the anæsthesia is slight, and the same may be said of lead palsy. In infantile paralysis the sensation is almost invariably preserved.

Pain and paralysis are sometimes combined. In such cases we must first ascertain, if possible, whether the apparent paralysis may not really be due to the pain. In severe neuralgia of the face, or of a limb, or in pain from diseased joints and the like, the parts cannot be moved on account of the commanding nature of the pain; in cases of muscular pain, as in a common stiff neck, the absence of motion is no doubt due chiefly to this; in certain forms of what is termed "rheumatic paralysis," however, the inability to move the part affected seems to be partly owing to this pain and partly to a rheumatic affection of the nerves or their sheaths impairing their function. When the pain in paralysis is not of this character, we ascertain if the skin and muscles of the affected limb are tender on pressure, or if the pains come in severe darts of momentary duration, or if they are associated with cramps, permanent contractions, or startings of the limbs. Thus cerebral meningitis is often associated at its commencement with a generalized "hyperæsthesia," and this is likewise noticeable in some cases of hemiplegia; spinal meningitis, by its attendant pains, may simulate rheumatism; lesions of the cord may give rise to pains resembling sciatica and other forms of neuralgia or rheumatism in the limbs; "electric" or "toothache-like" pains in the legs are habitual in locomotor ataxy; the pain at the beginning of infantile paralysis may be such as to give rise to a suspicion of hip-joint disease; pains of various degrees of intensity occur likewise in wasting palsy.

The condition of the paralyzed limbs and muscles must be ascertained. Diminution in bulk, firmness, and temperature are often found even in recent cases of the atrophic paralysis of infants, and in old cases of various forms of paralysis. Occasionally a relative increase of temperature can be made out in the paralyzed limbs in the early stage of hemiplegia, but a slight difference in the opposite direction is much commoner later on. The muscles are to be examined as to their bulk; we look to see whether they are apparently larger than normal, as in pseudo-hypertrophic muscular paralysis where the bulk of muscle contrasts with the feebleness of the limbs. More often they are smaller and softer than natural, but in judging of this we must allow for the changes brought about by disuse from any cause; wasting is specially noticeable in cases of mechanical injury of the nerves, in wasting palsy, infantile paralysis, and certain other forms of spinal paralysis. Small fragments of muscle have been sometimes removed by Duchenne's *emporte-pièce histologique* to ascertain whether the muscular fibres have undergone fatty degeneration, or have been replaced by fibrous tissue. We also examine the muscles as to the power remaining in them; the dynamometer is sometimes useful in recording the force, especially as a test of improvement or deterioration in this respect; considerable variations occur with the dynamometer from a varying degree of tact in using it. The commonly used dynamometer is only available for the hands (see Fig. 34); more elaborate instruments for testing the legs and other parts are also occasionally employed. Grasping the fingers of the observer, pushing the foot against his hand, raising the arm or leg into certain positions, and holding out weights, etc., may be mentioned as rough tests of the muscular power. Coarse trials of mere strength like these may fail to reveal defects in the more delicate exercise and adjustment of the muscles required in using tools, in writing, sewing, etc., and the influence of anæsthesia is often very potent in leading to difficulties in such operations; it may of itself readily simulate a paralysis of the

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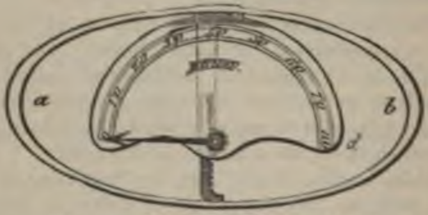
[1] For the more elaborate determination of the "Functional relations of the motor roots of the brachial and lumbo-sacral plexuses," see Ferrier, Proceedings of the Royal Society, vols. xxxii. and xxxv., London, 1881 and 1883.

FIG. 34.



Dynamometer. a-b is a powerful spring; c-d is the scale indicating the pressure in kilogrammes.

movements. Unsteadiness and spasm may come into play likewise to spoil the muscular movements. (See pp. 215, 223, 253.)

The electric exploration of muscles is of considerable value; this is dealt with in a special section. (See electrical instruments, Chapter VII.) The so-called muscular sense is also dealt with in another place. (See Chapter V., p. 200.)

The condition of the muscles as to permanent contraction, remittent spasm, movements, and tremors must be considered in cases of paralysis. Rigidity of the paralyzed limbs should be inquired into as to whether it appeared at the beginning of the paralysis, or not till afterward. In some cases, with the onset of the hemiplegia, there is an "initial rigidity;" or in a few days an "early rigidity;" or in the course of months a "late rigidity;" and when from long continuance of this the tendons and joints are fixed we have a "structural rigidity." The early forms of rigidity no doubt depend on the irritative nature of the lesion very often in the cortex of the brain or its membranes and on the changes set up there; the late rigidity usually depends on descending sclerosis, involving the antero-lateral columns, resulting from the primary lesion. In testing the condition we try whether we can stretch out the rigid limbs, and whether this causes pain; also whether any involuntary movements exist in the contracted member, whether the contraction is associated with tonic spasm of the muscles, and whether this spasm, if present, ever gives way to relaxation.

Trophic lesions in paralysis are not uncommon. The temperature of the paralyzed limb is often a little lower than usual; but an excessive coldness, soon developed after the attack, constitutes a leading feature of infantile paralysis. In this disease, however, the limb becomes rapidly soft and wasted, and not unfrequently it is found after a time to have grown less than its neighbor even in length.

The formation of bedsores is one of the most serious of the trophic lesions. Paralyzed patients are, of course, from their helplessness in movement, specially liable to the formation of bedsores in the same way as other patients long confined to one position; and this tendency is much aggravated when, as often happens, there is the irritation from the involuntary evacuation of urine and feces to contend with. In certain cases of paralysis from acute myelitis we sometimes find large "bedsores" produced in the course of three or four days, evidently due not to pressure, but to diminished vitality in the part. For although such a sore is spoken of as "acute decubitus," we sometimes find it on such a part of the body as to put the influence of injurious pressure, or even of the irritation of urine, quite out of the question, say, for example, on the anterior part of the thigh. No doubt the sores are usually in such parts as to allow of great aggravation of the mischief from pressure and irritation.

The first appearance is redness, then little vesicles or one large blister, and then a gangrenous sore, unless, as seldom happens, the blisters shrivel up and dry without further mischief. The whole process may occur with the most astonishing rapidity, and when it goes on to a serious extent it may lead to secondary febrile disturbance.

Although bedsores of this description are much commoner in spinal than cerebral cases, similar trophic lesions can be seen at times in hemiplegic attacks; when in such cases the sore appears on the buttock, rather than the sacrum, and only affects the paralyzed side, we have a strong suggestion of its dependence on loss of innervation.

The implication of the joints described by Charcot, and of the skin, nails, and cornea, have been already described. (See pp. 148 and 159.)

Involuntary movements in paralyzed limbs must be noted when present. In chorea the erratic movements are often complicated with a certain degree of paralysis. Both the movements and the paralysis are usually more pronounced on one side than on the other. Occasionally the chorea is limited to one side (hemichorea), and the paralytic complication, when present, usually attacks the side chiefly affected with the twitchings. This paralysis generally follows the chorea, sometimes precedes it. Of a somewhat similar nature is the transient hemiplegia which sometimes follows epileptic convulsions (epileptic hemiplegia).

Unilateral convulsions sometimes usher in a hemiplegia; sometimes such convulsions occur or recur in the course of the paralysis. Such convulsions may take place without loss of consciousness, and may be limited to a paralyzed arm or leg.

Paralyzed limbs sometimes move involuntarily in connection with automatic actions, particularly the arm in the act of yawning. Movements of the legs, quite involuntarily, are common in paraplegia; where the spinal cord is seriously destroyed, these may be very marked and even violent; they are often produced by very slight irritations acting in a reflex manner; occasionally the exciting cause is plain enough, as when the irritation is from exposure to cold air, or from rubbing of the bedclothes in turning them down, etc.; but sometimes the cause is not apparent; the urinary passages and the bowels are no doubt at times the seat of such hidden irritations.

Choreic movements sometimes become developed in paralyzed limbs in hemiplegia (post-hemiplegic chorea); these differ from Dr. Hammond's "athetosis," as in this latter affection there is no history of preëxisting hemiplegia, although a certain loss of power may coexist with it. A minute fibrillary quivering under the skin is observed sometimes in cases of muscular atrophy; similar quivering is noticeable in the tongue and lips in general paralysis, delirium tremens, and some other affections.

A degree of irregular muscular movement or tremor is seen in certain forms and stages of cerebral and cerebellar disease, locomotor ataxy, cerebro-spinal sclerosis, and general paralysis; some of these peculiarities will be noticed in the section on unsteadiness in balancing the body, and in walking; such complex efforts bring out the deficiency in a marked manner. (See p. 222.) It must not be forgotten that simple weakness renders the limbs unsteady as well as feeble, and various febrile states intensify the trembling as well as the weakness (delirium tremens, typhus, etc.).

Shaking of the paralyzed limbs is not uncommon in hemiplegia—tremulous vibrations differing from choreic movements in being somewhat rhythmical in their character and much more limited in their extent; this general shaking of the whole limb resembles that which may occur after unwonted muscular efforts. We may have this shaking developed without any preceding hemiplegia or paralysis, although when established it amounts to a virtual paralysis, and is named "paralysis agitans," or "shaking palsy." Such shaking is often unilateral; sometimes it affects only one limb; sometimes the head is notably affected with similar shaking or nodding movements. It should be noted whether the tremor is only brought on during muscular exertions, or whether it persists during repose. Along with this shaking we often observe emotional disturbances, and sometimes that peculiar gait termed "festination," in which the patient has to hurry on to keep himself from tumbling forward, always "in pursuit of his centre of gravity," as has been said. Such affections are most common in the aged, or those past middle life; but a similar affection, due to cerebro-spinal sclerosis, is sometimes seen in younger persons, often associated with shaking of the head and with nystagmus. The twitchings of special muscular fibres in cases of facial paralysis which have practically recovered, may be mentioned here. These twitchings occur in certain cases quite apart from electrical treatment although this is sometimes blamed for them.

"Nodding convulsions," with nodding, bending, rotating, or bowing of the head or of the body, constitute a rare disease observed in young children; it is described also under the names of "eclampsia nutans," and "salaam convulsions."

Somewhat intermediate between chorea-like movements and shaking palsy are the tremors seen in mercurial paralysis, and some other forms of metallic poisoning. The occupation of the patients, and the existence of salivation, etc., assist us in the diagnosis.

Reflex action has already been referred to as accounting for certain involuntary movements in paralyzed limbs; but we often produce these deliberately, for purposes of diagnosis. When reflex movement is preserved we infer that the loop of nervous connection to and from the spinal cord is intact—the sensory or afferent nerves, the part of the spinal cord concerned, and the efferent or motor nerves. It is evident that serious disease in any part of this loop may interfere with the reflex action. In particular, the practical integrity of the gray matter of the cord, at a given level, may be thus inferred, although serious disease may exist above or below this point. Indeed, the reflexes are often increased when serious lesions in the cord exist above the level of this loop, probably because the influence from the controlling centres in the spinal cord and also in the brain are thereby cut off; owing to the absence of cerebral control somewhat similar results may follow from disease in the brain itself. The presence of normal, diminished, or excessive reflex action affords thus an important index of the state of the nervous centres. Information as to the integrity of the afferent and efferent nerves may also be gathered, as we may find by this test that they can transmit nervous impulses although sensation and voluntary movement may be both quite lost. When the reflexes are preserved the nutrition of the muscles and their response to electricity are usually but little impaired. In the study of the reflexes a comparison of the two sides of the body affords important indications, particularly as the amount of reflex movement varies much in individual cases even in health.

Superficial Reflexes—The most familiar illustration of these is the plantar reflex—the movement obtained in the toes on tickling the soles of the feet. This may often be obtained in profound paralysis, involving the motion and sensation alike, and the movements may occur without the patient's consciousness. In health, a strong will can inhibit these reflex movements; but when the influence of the brain is cut off, by a grave lesion of the cord higher up, the part is given over completely to the reflex impulse. We can often trace variations in the movements according to the varying intensity of the stimulus. Thus a slight tickling may make the toes only move; stronger impressions by scratching and pricking may make the foot and leg jerk up; these stimuli when of a more violent character may cause the thigh to be pulled up to the belly; or may even excite movements in the leg of the opposite side. By grasping the first metatarsal bone firmly between the finger and thumb, this reflex movement can often be well felt, say in cases of paralysis from Pott's disease of the spine; the interval between the impression and the movement, and the comparative slowness of the action contrast well with the sudden movements produced voluntarily. Very occasionally movements may be produced in the same way in a paralyzed arm, in cases of hemiplegia due to brain disease. The reflex movements of the palate have been already referred to in connection with the testing of the cranial nerves. (See p. 204.)

The superficial reflexes have been specially studied by Dr. Gowers, who has formulated the following indications to be drawn from them. In beginning the study of these reflexes, the student would do well to try them first in some young subject, free from nervous disease, as they can then be seen to perfection. In older subjects the reactions are not usually so striking, or some of them may even be absent apart from any nervous disease.

Plantar reflex: stroking the sole of the foot causes movements of the toes: the part of the cord concerned is the lower part of the lumbar enlargement.

Gluteal reflex: firm, sudden stroking with the finger of the skin over the buttock, gives rise, sometimes, to reflex contraction of the glutei; the part of the cord concerned is at the origin of the fourth or fifth lumbar nerve.

Cremasteric reflex: stimulation of the skin at the inner aspect of one thigh, causes retraction of the testicle on the same side: both are often pulled up by more violent irritation: sometimes, however, this reflex is absent: the part of the cord concerned is at the origin of the first and second lumbar nerves.

Abdominal reflex: sharp, sudden stroking of the abdominal wall from the lower margin of the ribs downward, about the line of the nipple, gives rise to contraction of the muscles in the region of the umbilicus: the part of the cord concerned is at the origin of the eighth to twelfth dorsal nerves.

Epigastric reflex: a firm, downward stroke on the ribs in the infra-axillary region, gives rise to a dimpling in the epigastrium: the part of the cord concerned is at the origin of the fourth to the sixth or seventh dorsal nerves.

Scapular reflex: irritation of the interscapular region gives rise to contraction of the scapular muscles, and especially the posterior fold of axilla: the part of the cord concerned is at the origin of the two or three lower cervical and two or three upper dorsal nerves.

Dorsal and lumbar reflexes: the erector spinæ muscles may be stimulated, at various levels, by irritation of the skin along their edges. These serve to corroborate the other reflexes.

"*Deep Reflexes.*"—This name is applied to the responses obtained on striking tendons or muscles under certain conditions of tension: the name may also be extended to the rhythmical clonic contractions induced by forcing the feet into certain positions. The exact physiological nature of these so-called reflexes is still disputed, but it seems generally agreed that the normal reaction requires the integrity of the nervous loop to and from the spine as in true reflexes. These deep reflexes may be diminished or abolished in disease, or, on the other hand, they may be unduly increased.

Curious changes in the reactions are found temporarily in connection with chloroform narcosis, the peculiar condition of the nervous system existing after epileptic fits, and at the very onset of hemiplegic attacks: in the following remarks the more permanent and common conditions only will be dealt with.

The knee-jerk is perhaps the best name for the forward jerk obtained on striking the patellar tendon (called also "patellar tendon reflex," and the "knee phenomenon"). The best way is to make the patient cross the one leg over the other, allowing it to hang in an easy position: or if there is any difficulty from obesity, stiffness, or otherwise, he may be placed on a high stool, or table, with his legs dangling over the edge: or the hand or the arm of the observer may be passed under the knee to be examined, so as to elevate it from the ground and to support it fully while the patient is seated on an ordinary chair. These positions give a moderate amount of stretching of the quadriceps extensor muscle, and allow of ready movement of the limb. The region of the tendon, just below the patella, is then sharply struck with the points of the fingers, or with the ulnar edge of the hand; when there is any difficulty in getting the response it is well to bare the knee, taking care that the clothing, if turned up, does not interfere with the free movement of the limb, and then to strike the tendon in the place indicated, or to direct a stroke on it with a percussion hammer. The foot and leg in the normal state are then jerked forward instantly. The amount and readiness of the response varies in different subjects, even in health: it is seldom completely absent, although at times it requires a little care to bring it out, especially in securing free suspension of the limb and in directing the tap to the proper spot: it is also sometimes desirable to direct the patient's attention to some muscular effort with his hands by pulling or pressing, so as to allow the experiment on his knee to escape any perturbing influence from his watching it. When the patient is confined to bed the knee may be supported by lifting and steadying it by means of the hand placed behind it: or the patella may be pressed as far down as possible while the leg lies extended on the bed, and while the muscle is thus stretched, the finger holding the patella is suddenly struck so as to tend to depress the patella further, when an upward jerk of the patella as it is drawn up by the muscle can be seen or felt by the observer.

The absence or diminution of the knee-jerk is almost constant in locomotor ataxy, even in the early stages: very exceptionally a regular case of the disease is found with this reflex preserved. In the so-called "hereditary ataxy" (Friedreich's disease) the knee-jerk is usually exaggerated instead of being diminished. Other forms of paralytic disease may also be characterized by this absence. Of course, when the lower portion of the cord presents destructive lesions no response can be obtained, but it may also be absent in less grave forms of disease, as in alcoholic paraplegia, diphtheritic paralysis, infantile paralysis, and other forms of poliomyelitis anterior, and wasting palsy, involving the legs and thighs; in pseudo-hypertrophic muscular paralysis it is also usually absent, and in some general diseases it may also be lost: thus in diabetes mellitus it is frequently absent, or, at least, very faintly marked.

Increase of the knee-jerk is an equally important symptom in certain diseases: when it is extreme the slightest tap with a finger suffices to make the leg jump forward, and a rapid succession of light taps may be found to keep the leg stretched out during their continuance. This increase in the knee-jerk is found to be associated most often with sclerosis of the lateral columns of the cord—whether this is primary or secondary. In the secondary forms, the degeneration may be due to a lesion in the brain cutting off the due motor impulses, and so we find lateral sclerosis and increased knee-jerk in the late rigidity of hemiplegia on the paralyzed side only. Or mischief in the cord (as in Pott's curvature) may lead to degeneration in those columns below the site of the lesion: this usually affects both halves of the cord, and so the sclerosis, and the increased knee-jerk are on both sides. In disseminated sclerosis also, probably from implication of the lateral columns, the knee-jerk is usually intensified.

In all these forms of disease there is apt to be, in bad cases at least, more or less of the spastic condition: when spasm is well marked, increased knee-jerk is usually also present.

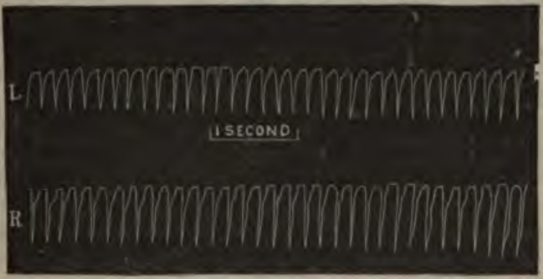
Increase of the knee-jerk is often associated with "ankle clonus."

Ankle clonus is brought out in patients who present this "foot phenomenon," as it is also called, by pressing the foot upward at the ball of the toes, toward the tibia. It is best to have the knee only very slightly bent, whether the patient is sitting or lying. The upward pressure should be sudden and forcible, and it ought to be continued for some seconds, even if no trembling occurs at first. While the gastrocnemius is thus stretched, a sudden stroke on the tendo Achillis often helps to determine the clonic contractions. These are rhythmical in character, and their uniform rate, 6 to 10 in a second, can be shown by a recording apparatus. They are quite beyond the control of the patient, unless indeed by changing the position of the foot or leg.

Ankle clonus, unlike the knee jerk, is not developed in the normal condition; its affinities are with the *exaggerated* not the normal knee-jerk. No doubt both in healthy and diseased subjects a slight tremor, as if the clonus were about to begin, is often found for a second or two, but no continuous rhythmical movements occur. In healthy subjects they may sometimes be induced by sitting far forward on the edge of a chair, resting the foot on the ball of the toes, and beginning *voluntarily* a movement of the leg as if dandling a baby on the knee; after a time these movements may be continued automatically with the foot in this position. A somewhat similar plan often succeeds in producing the rhythmical clonus in paralysis; the patient is seated on a chair pretty well forward, with his feet on the ground, resting on the toes, a little behind the vertical line of his knees; the pressure upward is thus made by the floor opposing the weight of the foot instead of by the hand of the observer as in the other plan. When thus placed the rhythmical movements often begin at once, but the toes are apt to slip forward, so stopping the clonus; it is well, therefore, for the observer to place his own foot or some heavy object in front of the patient's toes. Frequently, however, the clonus does not start at once when the patient is so placed, but does so after a little interval; a sharp tap downward on the knee or a stroke on the tendo Achillis may suffice to set it up at once and it may then go on for many minutes.

When thus established, both legs can often be made to go at the same time and at the same rate. (See Fig. 35.) But it seems as if the movements in the two legs were not synchronous; indeed they appear to the eye rather to alternate with each other in their elevation and depression—so far like the alternate action of the legs in walking—this is not brought out in the tracing here given, probably because the rate of revolution of the recording cylinder was not rapid enough, and the adjustment of the levers not quite perfect. In many cases the clonus thus set up invades the muscles higher up, and we may have a simultaneous clonic rhythmical contraction of the adductors of the thigh, the whole limb becoming thus violently agitated. The association of ankle clonus with the more extreme forms of exaggerated knee-jerk is very

FIG. 35.



Simultaneous tracing of the foot or ankle clonus in both legs.

close, and its clinical significance is much the same, pointing often to the occurrence of sclerosis of the lateral columns. Sometimes, however, the descending changes have not apparently had time to go this length, the lesion in the cord only cutting off, so far, the inhibitory action of centres in the brain or perhaps in the cord itself. Certainly ankle clonus may be found in a case of Pott's disease, with a spastic state of the muscles, which may be recovered from, the cord, therefore, being presumably free from profound changes in the lateral columns of the kind referred to. Its occurrence in connection with chloroform narcosis and epileptic fits also points to its arising apart from permanent organic changes. It also occurs sometimes in chronic rheumatic cases, and even in the debility and disease resulting from an attack of fever.

It is disputed whether it ever occurs in cases of pure hysterical paralysis; certainly its presence in suspected cases of this kind should make us all the more careful in our examination before forming such a diagnosis.

Occasionally ankle clonus can be obtained in cases not characterized by an increased knee-jerk especially in disseminated sclerosis.

Increased reflex in the tendons of the arm and wrist. Front tap contraction. These evidences of "myotatic irritability," as it has been called, can often be obtained in the same kind of cases as furnish increased knee-jerk. Tapping the muscles and tendons in the arm and wrist, particularly in cases with rigidity, leads to marked contractions.

If the leg be held out, and the foot slightly bent upward, a tap on the muscles on the front may lead to a more or less distinct contraction of the muscles in the calf.

Walking and balancing in paralysis. The power of balancing the body varies much in different forms of paralysis; it is sometimes very deficient in cases where the loss of muscular power is but slight. This want of power in balancing often comes out when the patient tries to walk. In children the complaint of inability to walk is sometimes made when the real defect is in the intelligence (idiocy). Lateness of walking in children often arises from the constitutional affection known as rickets, apart from any true paralysis.

The manner of walking must always be scrutinized in cases of paralysis. In hemiplegia the paralyzed leg is often swung from the trunk, and the toe of the paralyzed leg may drag or scrape as it goes along, so that it makes a mark, for example, on a gravel walk. When infantile paralysis affects one of the lower limbs, the chief deficiency is almost invariably below the knee, and when the loss of power is not extreme the foot during walking is swung round or "thrown," as the parents say, in a very characteristic manner. In paraplegia the feet may almost be said to be trailed along when the paralysis is considerable; when one leg is worse than the other this trailing often serves to distinguish it. In less severe cases the feet and legs are lifted with an obvious effort. The hurrying gait known as "festination," already referred to, may exist in all degrees from a slight hurrying and a slight difficulty in stopping, up to the most extreme running and staggering forward to an extent that is quite alarming. At other times there is the appearance of hurrying with very small steps; these small steps, with the feet scarcely raised at all from the ground, are often met with in serious forms of brain disease, usually in the aged.

The element of spasm is an important one in the gait of the patient. When the adductors of the thigh are in a state of spasm the legs cross each other in such an active manner as to render progression almost impossible. When the muscles of the calf are affected the patient walks on his toes, and he may be jerked upward as he moves with something like a hop (high action). Sometimes an upward jerk with each step, although associated with walking on the toes, is due to voluntary rather than spasmodic action, the patient trying thus to keep from tripping with his toes. In some cases the spasm is only induced at the beginning of a muscular effort. (See p. 225.) In many cases of sclerosis with a spastic condition of the muscles the shaking of the feet, as in incipient ankle clonus, can be noticed, as the toes are brought down to or are just leaving the ground. The distortions from paralysis of special groups of muscles assume the various forms of talipes—varus, valgus, and calcaneus.

Staggering in a most extreme form is often found in disease of the cerebellum, so that the patient in a bad case cannot make a few steps forward without staggering to the one side. Similar deviation to the one side is one of the symptoms in Ménière's disease. The influence of ocular paralysis and vertigo in causing staggering must also be remembered. (See pp. 169, 190, 257.) Patients affected with staggering are apt to be suspected of intemperance.

In locomotor ataxy and in general paralysis of the insane there is frequently very marked unsteadiness in walking and standing, but special tests require to be applied in some cases to bring this out. We ask the patient to walk along a given line; the seam of a carpet or a plank of the floor answers for this purpose. Or we ask him to put his feet together and to stand still; or we ask him to stand on one foot and then on the other. In ordinary paraplegia when the patient gets fairly into the erect position he can often stand very firmly; any deficiency in this respect usually arises from the knees giving way from muscular weakness, and with care in adjusting himself such a person can even stand on a single foot. In locomotor ataxy this power is remarkably diminished. A patient who can walk fairly is unable to stand steadily, he cannot get a "grip of the ground," he says, and requires to spread out his feet and to keep a strict watch with his eyes on the ground. This relationship of the sight to the power of balancing must be specially considered in cases of suspected ataxy. It comes out to its greatest extent when the patient puts his feet close together and tries to balance himself with his eyes shut; a good method of testing, especially with the view of tracing any improvement or deterioration, is to count the number of seconds during which such a patient can thus remain: care must be taken to have assistance at hand, not only to prevent actual accidents, but also to give the patient a feeling of security in submitting to the test. A further indication of the importance of the eyesight in balancing comes out in the event of the patient having to walk in the dark, or as happens in certain cases, in the event of blindness coming on; we may also apply the test by seeing how he can walk while looking up toward the ceiling instead of at his feet: interesting experiments may also be made by blindfolding the patient and seeing what he can do in rising from the ground, walking, etc. Another test, combining some of these, consists in trying if the patient can walk backward. The least hold of anything often assists wonderfully in steadying the patient in this condition, the hand, like the eye, coming to the assistance of the lower limbs. A striking peculiarity in the walking of such patients consists in the way in which they very often raise their feet much higher than is requisite, and stamp them down with unnecessary force. All these peculiarities seem to depend in part on the diminished sensibility of the skin of the feet, but chiefly on a want of the delicate adjustments of the force in the various muscles required for a particular effort. A further test is supplied by the act of turning right round while walking back and forward. Deficiency in this respect appears in many cases of general paralysis also.

Various defects in walking appear in connection with other affections as well as paralysis proper. The most important of these is disease of the joints and especially of the hip-joint, so that we have often to scrutinize the symptoms, measure the limb, and test for localized pain by pressure and percussion, before coming to a decision. In children, particularly from there being often but little pain, the distinction between hip-joint disease and infantile paralysis is sometimes very difficult to establish, and a similar difficulty arises when it happens that the pains in the early stage of infantile paralysis resemble those of hip-joint disease; the measurement of the limb, the examination of the joint, the temperature of the paralyzed leg, the electrical reaction and the nutrition of the muscles, with the history of the case must guide the diagnosis. Abscesses of various kinds, involving the psoas and iliacus, and some rheumatic affections of the muscles, may give rise to difficulties in walking bearing some resemblance to paralysis. In addition to these, confusion may arise from affections of the joints of the chronic rheumatic type, with enlargement of the ends of the bones or even at times partial dislocation and more or less grating on movement. Such affections may simulate paralysis from impairing the movements, but somewhat similar disorders in the joints arise in some cases of locomotor ataxy and other forms of disease in the cord. (Charcot.)

Rising from the sitting or recumbent posture affords often a valuable means of testing the strength or of observing the weakness of certain groups of muscles. The remarkable way in which a child with pseudo-hypertrophic muscular paralysis turns round to his knees and then helps himself up with his hands on his thighs, so long as his power is equal even to this, is almost pathognomonic. In muscular atrophy also the special weakness can often be thus seen. A difficulty in rising from a seat constitutes a leading feature of the paralytic disease described by Thomsen: in this affection any call on the voluntary muscles for action, after a period of rest, is attended with the development of spasm and rigidity in various parts of the body lasting for some little time; the difficulty in rising is only a part of the disorder, although from the previous rest in the sitting posture this is one of the notable features of the disorder; it is said to date from childhood and to be distinctly hereditary.

Difficulties as to speech require very special study in cases of paralysis. A patient may be unable to speak or to answer a question because of unconsciousness or impaired intelligence (idiocy or dementia of any kind); congenital or other defects in the hearing and in the vocal organs need only be mentioned. When the inability arises from such causes, the general aspect of the patient and the previous history usually guide us aright. In other cases, the loss of articulate speech is associated with such obvious paralysis of the tongue, lips, and palate, that we can very safely refer the loss of speech, or the defective utterance to this cause. In such cases we must test the motor power of these parts in various ways. (See seventh, eighth, and ninth nerves, pp. 203–206.) A further assistance is given in this matter by ascertaining which are the most imperfect sounds; the pronunciation of the labials in particular is often affected from paralysis of the lips, and a nasal tone may be communicated to the voice from paralysis of the palate.

Certain defects remain which cannot be explained at all in this way, and there are others which are only partially intelligible on such a view. When for example a patient cannot speak, or can use only one or two simple words to express himself, and is yet able to repeat lists of words, or even sentences dictated to him, it becomes clear that the defect is not due to any want in the muscular and nervous mechanism of the organs. This is equally clear in those cases where the patient's difficulty occurs only or chiefly with the names of objects and persons. To the affections of speech indicated in this paragraph the term "aphasia" is applied.

Aphasia must be studied and described as to its various forms. The patient can sometimes express himself quite correctly in writing, although unable to speak; to this rare condition the term "aphemia" is applied by some. He appears sometimes to understand words addressed to him perfectly, although unable to speak, or at least to go beyond a word or two. In other cases words addressed to him may seem to convey no meaning at all. This condition must be tested by asking the patient to do certain things, carefully avoiding any suggestive gestures in making the request, or in particular asking him to do something absurd, or at least very unusual. He may be able to say certain words or parts of sentences while stumbling almost exclusively at names; he may know when the right name for the object or person is supplied to him, or he may supply wrong names, although conscious that they are wrong, and quite clear as to what he really means. A patient who can scarcely say "yes" or "no" correctly may be able to repeat words and short sentences after they are dictated to him although unable to originate them; or even to recite familiar passages, such as the Lord's Prayer, pieces of poetry, etc., especially when these are started for him. Aphasic patients have usually one or two words, especially "yes" or "no;" when they have only one of these its affirmative or negative meaning may be clearly expressed by the patient through variations in the tone or gesture. They have often certain phrases and expressions which are brought out in a parrot-like manner, although at times they are deceptive from fitting admirably as answers (*e. g.* "I cannot tell"). Exclamations of anger, surprise, etc., and oaths are sometimes given utterance to at odd times by those quite unable to speak unless thus surprised into such emotional expressions. Aphasic patients can often sing or hum tunes, although unable to use words or only to use a few; while singing, a freer use of words is often noticeable. Writing is an important test to be applied to aphasic patients. A few can express themselves in writing quite well although they cannot speak. When from paralysis of the right arm the patient cannot write, movable letters may be tried. Various degrees of ability are seen in aphasia in this respect, but anything like perfect use of writing is very rare. A strange medley of words, or stray words and confused combinations of strokes and syllables, are often shown by aphasics with obvious self-satisfaction: or in slight cases, only an occasional wrong word is found, and these errors may be intelligible in view of the similarity in sound, or some other explanation may be found from the context: or as in the speech of aphasics portions of words may be transposed and part of one word put on to another. Some, however, can write words to dictation who cannot originate a written sentence. Many can write words and long sentences from a copy supplied to them. Some can copy from printed characters into ordinary writing; others can only copy as if by pure imitation. Some can identify their own names or the names of friends in a long list, whether in written or printed characters, although they do not know the individual letters; the general appearance of the familiar word probably guides them. Many aphasics appear to read books with interest—although probably gaining no idea from the process; we must test them as to their knowledge of what they seem to be reading. A patient with complete loss of speech not having even the power of saying "yes" or "no" was found to be able to understand a paragraph in a newspaper and could write down one or two simple words correctly when questioned on its contents. Persistent aphasia may exist along with but little diminution of high mental power, but the intelligence is usually seriously impaired, even more than might appear on a preliminary investigation.

These details indicate the points to be noted in connection with the study of the varying gradations of the affection in aphasic patients; such a note of the actual state is better than applying mere names to characterize the kind of aphasia, as these usually imply artificial distinctions and theoretical considerations not fully justified by the facts. A most important distinction, however, is between sensory and motor aphasia. In the former the patient may be found to be quite unable to understand words or names of objects repeated again and again in his hearing (word-deafness); or what is more common, he may be quite unable to recognize words or names of objects written or printed before him (word-blindness). Occasionally, a patient unable to repeat a word or name when pronounced, can at once do so when he sees it in written or printed characters; it is very common to find an aphasic able to repeat a word when pronounced to him although unable to do so when shown the same word or the object referred to. In sensory aphasia there is often no hemiplegia.

In motor aphasia the understanding of spoken language may be perfect, and even at times the power of reading may be preserved almost intact, and yet the loss of language for expressing the simplest ideas may be extreme or indeed complete.

The clinical fact most frequently associated with aphasia is right hemiplegia, in rare cases there is left hemiplegia; in the latter event we should inquire if the patient is left-handed. Unilateral convulsions and other evidences of cerebral disturbance are not uncommon. The cerebral lesion which most often leads to aphasia is embolism of the left middle cerebral artery and the softening and destruction of portions of the brain structure supplied by this vessel; of course, thrombosis may lead to the same result. The suddenness and extent of the cerebral lesion seem to play an important part in determining the occurrence of this symptom; the lesion is usually found to implicate the posterior part of the third frontal convolution on the left side or at least the parts in its immediate vicinity, such as the lower part of the ascending frontal convolution; when, however, the aphasia is of the sensory variety—word-blindness and word-deafness—the angular gyrus and the first left temporo-sphenoidal convolution are supposed to be involved. When aphasia exists without distinct hemiplegia, it may still be clear from other symptoms that it is connected with cerebral disease. Aphasia occurs sometimes in chorea in a marked manner, and much oftener in a slight form; such attacks of chorea usually present some degree of paralysis, and of slight or transient dementia. Aphasia without any history of paralysis of any kind is most commonly observed after severe illnesses—after enteric fever, for example, in children; it is usually only temporary in such cases.

The *power of writing* is often affected in paralysis; the importance of testing this has already been referred to in connection with aphasia; the difficulty of finding words, and the confusion of speech are often admirably reflected in the writing when the affection is slight. This concerns the power to form words and sentences, but even the mechanical part of the handwriting may afford useful indications. In paralysis agitans, in general paralysis, in chorea, in cerebrospinal sclerosis, and in the forms of locomotor ataxy affecting the arms, the unsteadiness is shown in the writing; even when one cannot observe this distinctly, there is sometimes clear proof of a departure from the usual character of the writing. This affection of the writing varies considerably at different times, and is apt to be made worse by having the attention of onlookers directed to the writer. When there is anæsthesia of the fingers, or paralysis of the muscles of the hand and thumb, the writing is also apt to be affected, as the patient cannot guide the pen properly.

Different from all these is the peculiar spasm which seizes the fingers in "writer's cramp;" when the patient begins to use the pen, the movements soon get to be beyond control, and the pen cannot even be held. In less severe forms the spasm only appears after a certain amount of writing has been done, and the difference in the character of the writing at the end from the beginning can be readily noticed. When there is any form of affection of the writing it is well to preserve specimens, containing the date, for comparison subsequently.

In cases of insanity it is often well to test the patient by getting him to express his ideas in writing, for another reason, as he becomes more apt to wander into extravagant ideas when the restraining influence of an incredulous listener is removed.

PARALYSIS OF THE BLADDER AND RECTUM is an important fact in cases of paralysis, and always constitutes a grave complication. This paralysis may show itself either by want of power in retaining the excretions till a suitable opportunity occurs (incontinence, paralysis of sphincters), or by a want of power in expelling the contents (constipation, retention of urine). It does not occur in hysterical paraplegia in a persistent form, although occasional retention of urine is often present in hysterical subjects. This form of paralysis is, likewise, *almost* unknown in infantile paralysis. But before considering paralysis, properly so called, reference may be made to conditions which simulate paralysis of these parts. The presence of coma or unconsciousness, from any cause, often leads to untimely intestinal and urinary evacuations, quite apart from any other defect. Similar causes may lead to retention of the urine; this is common in the unconsciousness found in serious febrile derangements, but also occurs in cases of paralysis of the nervous centres. Retention of urine is common in connection with injury of the parts, and after operations in the neighborhood of these organs; severe or instrumental labor, operations for piles, etc., may be named as common causes. Such retention may indeed be due to an inhibitory form of paralysis: very probably owing to the pain in the neighborhood of the bladder we may have retention in cases of peritonitis. Retention of the urine in connection with stricture or enlarged prostate, although no doubt partly due to nervous spasm, really depends upon distinct mechanical impediments.

The frequency of fistulous communications between the bladder and vagina in giving rise to dribbling away of the urine must always be remembered; occasionally the aperture is minute and sometimes it is situated within the uterus, instead of the vagina, requiring special investigation or the injection of fluids for its recognition. Dribbling away of the urine may be due to disease of the bladder, such as cystitis, arising from calculus or other causes; it may also result from the organ having been habitually, or on some special occasion, over-distended so as to injure the muscular and nervous structures. Involuntary evacuation of feces, apart from injury of the parts, may also result from great fluidity and frequency of the motions, from profound debility of the patient, or from great mental apathy; it is owing to this that such involuntary evacuations are always to be regarded as grave symptoms, especially in acute disease; they may also arise from anæsthesia of the anal aperture, so that due warning is not transmitted. Such motions occur also in idiotic persons. A form of local paralysis of the rectum, leading to retention of feces, is found in cases of constipation where the bowel has been habitually or enormously distended. The condition of irritability or spasm of the organs may lead to discharge of the contents beyond the patient's control. Dysentery, and other diseases characterized by tenesmus, cystitis, calculous disease of the bladder and kidney, etc., may act in this way, apart from any paralysis. (See "Disorders of defecation and urination," Chapters XI. and XIII.)

Spasmodic discharge of the urine, however, also occurs in spinal paralysis,—the bladder contracting on its contents with great force, and without much warning, and the patient being quite unable to restrain or delay the process. A somewhat similar suddenness and violence of contraction may also occur in the bowel, by which the patient is apt to be "taken short," as he says. Irregular action in this way sometimes occurs in locomotor ataxy as part, apparently, of the general incoördination; it may alternate with a sluggish action of the bladder.

Wetting the bed in the early hours of night is often complained of in the case of children (enuresis, nycturia). This seems also to be usually due to some form of spasmodic action, as it tends to occur soon after going to sleep, and long before the bladder can be much distended; indeed, it often occurs only during the early hours of sleep, and not at all later on, although there is then much more distention; during the day there is no trouble with the bladder in such cases. This ailment usually persists in the children affected for a considerable time, and seems due to some nervous defect; occasionally it is associated with and apparently due to phimosis. Wetting the bed occurs also in chorea. It sometimes affords an early indication of the occurrence of epileptic fits happening during the night, which might otherwise be overlooked. After enteric fever, and perhaps some other acute illnesses, this defect is occasionally noticed as a passing fact, in cases where there had been no trouble with the bladder during the height of the fever. It occurs especially in little girls, and seems part of the general weakness, both mental and physical, often found after this fever.

Paralysis of the bladder may show itself by retention, or by incontinence, or by spasmodic discharge of urine, in the same case: beginning as retention, incontinence may follow; or beginning with an irregular spasmodic action of the bladder, retention or incontinence may supervene.

Retention of urine is often associated with a kind of incontinence, only the overflow dribbling away, the retention may thus be overlooked altogether. More rarely a permanently distended bladder discharges portions of its contents in such natural quantities and at such intervals as to make the idea of retention seem very improbable. In old cases of stricture retention of urine to a *slight* extent, after the act of micturition, is quite a common occurrence.

Paralysis of the bladder is found in many cases of hemiplegia during its early stage, but it usually passes away as the patient partially recovers. Sometimes, however, it is permanent, and this is more likely to happen if the bladder has been neglected and allowed to be over-distended during the period of unconsciousness. Paralysis of the bladder is very common as part of the paralysis due to spinal lesions in the lower dorsal or lumbar regions, and in such cases it is more apt to be permanent. In whatever way the urinary affection begins, it tends to the form characterized by incontinence; disease of the bladder itself (cystitis) is also often present, produced partly, perhaps, by distention or by the use of instruments, favored by the alkaline urine often secreted in spinal paralysis, and by the ammoniacal decomposition which is so apt to work its way upward in such cases even when no instruments have been passed into the bladder.

A reflex paraplegia, originating from disease of the genito-urinary organs, is alleged to occur sometimes, and in any case, of the combination of the two sets of symptoms, we should try to ascertain the exact sequence of events; serious disease of the bladder occurring distinctly before the paralysis of the limbs points in this direction, but an incipient paralysis may manifest itself by urinary disturbance as an early feature; sometimes, indeed, an affection of the bladder remains the only evidence of paralysis for a long time.

Paralysis of the bowels usually manifests itself chiefly as a more or less obstinate constipation; this can be overcome, as a rule, by medicines, but occasionally it is so extreme as to suggest some serious obstruction, especially when from any cause vomiting supervenes. The paralysis may also affect the sphincters, leading to incontinence of feces, as already mentioned.

THE CLINICAL SIGNIFICANCE OF PARALYSIS in the various forms in which it appears has been alluded to occasionally in connection with special symptoms; the subject is so complex that reference must be made to the text-books under such headings as hemiplegia, paraplegia, diseases of the brain, spinal cord, etc.

Hemiplegia almost invariably implies a cerebral lesion; a few cases of spinal hemiplegia, however, have been recorded. When the face is involved in the hemiplegia, the diagnosis of some cerebral lesion may be made with confidence, and the lesion is always on the side of the brain *opposite* to that on which the limbs are paralyzed. The causes of the lesion must be searched for; we examine the state of the arteries for indications of rigidity, of the cornea for appearances of the arcus senilis, and of the heart for evidence of hypertrophy. When these exist in a hemiplegic patient not very much advanced in years, they strongly suggest a hemorrhagic lesion, and if the paralysis has been complicated by the occurrence of a fit of unconsciousness, with lividity and stertor, this may almost be regarded as certain. These remarks apply whether there is any evidence of chronic disease of the kidney or not; but the existence of such disease renders a hemorrhagic lesion in such a case even more probable. When there is valvular disease of the heart (with or without evidence of hypertrophy), we must keep in view the possibility of embolism; such attacks are usually sudden, and may or may not be attended with unconsciousness; embolism is, on the whole, commoner in the middle cerebral artery of the left side than in any other part of the brain, and this is a frequent cause of aphasia. Occasionally an embolism determines a profuse hemorrhage indirectly, through its first leading to the formation of a small aneurism at the bifurcation of the artery plugged by the clot.

The cerebral lesion in hemiplegia may be of the nature of softening; this may be a consequence of embolism, but may also arise from other forms of disease in the vessels (atheroma, thrombosis). Syphilitic lesions sometimes give warning of their presence, before the development of hemiplegia, not only by headache, but also by affections of single cranial nerves (third, fourth, fifth, sixth, and seventh in particular); these are sometimes recovered from, other nerves again becoming involved; syphilitic lesions often determine convulsions, occurring sometimes in connection with the beginning of the paralysis, sometimes before, and sometimes after it. Occasionally hemiplegia and paraplegia exist in the same subject from syphilitic lesions affecting both the brain and spinal cord; the indications of a multiple nervous lesion—one not easily explained by the simple growth of a tumor or the mere extension of the diseased condition—should always, in a young adult, suggest the question of syphilis. The existence of syphilitic nodes, iritis, retinitis, etc., must be inquired for, and the history of primary sores can sometimes be obtained in clearly syphilitic cases, although there may have been no appearance of secondary symptoms; in nervous cases the date of such infection is often very remote.

Cerebral tumor often causes paralysis of special cranial nerves before hemiplegia appears, or quite apart from it; in these cases the ophthalmoscopic appearances are specially important, as optic neuritis is very common in tumor; the comparative frequency of chronic tubercle of the brain and its membranes must be remembered in the case of children. Cerebral abscess may produce variable states of coma, and a shifting paralysis of various cranial nerves; it is sometimes indicated by the occurrence of shiverings and special sources of purulent infection can often be traced (from suppuration of the tympanum, from disease of the bones, from scarlatinal sore throat, etc.). Tumor and cerebral abscess are both apt to give rise to convulsions as well as to hemiplegia. Hemiplegia occasionally complicates pregnancy, passing away, it may be, soon after delivery: the urine is almost always albuminous in such cases, but their pathology still remains obscure.

In the puerperal state hemiplegia and aphasia sometimes result from embolism and thrombosis. Transient hemiplegia may follow a unilateral convulsion, and a more permanent hemiplegia is not uncommon in long-standing epilepsy, especially when this chiefly involves one side of the body. Cases of double hemiplegia with a spastic state of the muscles can sometimes be traced back to early life or even to birth.

Paraplegia may always be regarded as due to disease of the spinal cord or its membranes: even in the case of "reflex paralysis," as it is called, from irritation of the genito-urinary organs, there is probably always some lesion of the cord. In hysterical paralysis, however, which often assumes the paraplegic form, we cannot speak so definitely, and in some varieties of it, where it passes away rapidly and completely, we may be almost sure that no serious lesion exists. When the paraplegic patient complains of great pain in the limbs, as well as in the back, we suspect the membranes to be affected (spinal meningitis, whether primary or secondary); when reflex action is abolished and faradic contractility is rapidly lost, we infer destruction of some part of the cord itself, or of the cells in the anterior cornua, or of the motor roots; when reflex actions are greatly exaggerated, we infer the existence of a limited lesion in some parts of the cord. (See p. 217.) As to etiology, we must inquire for any history of strain as well as more obvious injuries to the column; such accidents often set up, in course of time, meningitis, or disease of the cord itself. Caries of the vertebræ is a common cause of paraplegia. This may not always manifest itself by distortion of the spine, even in cases which have gone on to the formation of psoas abscess. The influence of sexual excesses, in married life as well as otherwise, accounts for various forms of paraplegia proper, as well as locomotor ataxy. Sexual desire and power are usually diminished in cases of disease of the cord; occasionally, in early stages and certain forms of locomotor ataxy, an increased sexual capacity exists. Syphilitic lesions of the cord must be judged of on the same principles as those of the brain. It is generally agreed that syphilis is a common cause of locomotor ataxy.

Monoplegia—paralysis of one limb—is due to many different causes. Infantile paralysis, lead poisoning, wasting palsy, and traumatic lesions are the commonest; sometimes the injuries are not of a very glaring character, as in cases of paralysis of the arm, due to lying on it while asleep, and especially during intoxication or after great fatigue. Occasionally the injury to the nerve arises within—some tumor or pressure or destructive process affecting the functions of the nerve in its course. Occasionally, paralysis of an arm or a leg may result from cortical lesions in the brain, without any other obvious signs of central disease.

Infantile paralysis is no doubt essentially a spinal paralysis, the lesion, however, involves the anterior cornua alone or chiefly (poliomyelitis anterior); this localization accounts for the affection being almost invariably purely motor in character, for the coldness and great trophic changes, and for the limitation of the paralysis, in many of the cases, to one leg only, or to one arm. Not unfrequently, indeed, two or more limbs, or even the whole four limbs, may be attacked during the early period, the illness being characterized by pain and febrile disturbance; but the paralysis becomes, as a rule, more limited, and frequently settles down to one limb, or to one group of muscles. The rapid loss of the faradic contractility of the muscles, and their response to weak currents from a constant battery for a considerable time, are points of diagnostic value. An essentially similar form of paralysis occurs sometimes, but only rarely, in the adult from a similar lesion, and occasionally a form of the same disease, without any sudden beginning, can be recognized (poliomyelitis anterior chronica adultorum).

In *wasting palsy* the muscles are usually affected bilaterally, but one side is often in advance of the other: the muscles of the thumb and hand, the muscles of the feet, and the deltoids, are amongst those most frequently affected in the early stage, but nearly every group, including the respiratory series, may ultimately become involved. The muscles usually respond to faradic electricity pretty well, considering their loss in bulk.

Lead Palsy.—Paralysis of the extensors of the forearms, and more rarely of the legs, is frequently found in lead poisoning, the other muscles being intact: the sensation is sometimes affected, but not often to a marked extent. Traumatic paralysis from injury to the musculo-spiral nerve may simulate this; the history leaves no doubt in such cases, but in those forms supposed to be due to lying on the arm or to exposure to cold (so-called rheumatic), there may be, in patients exposed to lead, a certain difficulty. The immunity of the supinator longus in lead paralysis is important: it is tested by getting the patient to put his forearm in a position of half-flexion and half-pronation, and while he tries to retain it in this attitude, the observer proceeds forcibly to extend it; if the supinator longus be active it can be seen and felt resisting this extension (Duchenne). The diminution or abolition of the faradic contractility of the muscles in lead paralysis is an important fact, as this is almost always preserved in rheumatic affections of recent origin. The presence of a blue line at the free margin of the gums, the history of colic, and the occupation or surroundings of the patient are points to be scrutinized.

Alcoholic paralysis occurs in those much addicted to constant over-indulgence in alcohol. It affects the lower extremities much more frequently than the upper. It is often preceded by pains about the joints, and sometimes several slight paralytic conditions of a passing nature, occur before the more serious form sets in. Even when the paralysis is so distinct as to prevent walking, the loss of power is not by any means absolute: ataxic forms have also been described. With the paralysis there is œdema of the feet, especially when they are allowed to hang down. The knee jerk is diminished, and often completely abolished. Perversions of the sensation, with "hyperæsthesia" and diminution of the tactile sense, sometimes occur. Mental disorders may be associated with this condition, and the writer has observed, in particular, great loss of memory, affecting certain subjects only, with clear recollection of many others, in some cases of this disease.

When the alcoholic paralysis involves the upper limbs, a certain resemblance to lead palsy is observed, as the loss of power specially implicates the extensors, and the electrical reactions are somewhat similar in the two conditions. Muscular atrophy may occur as a complication.

Diphtheritic paralysis chiefly affects the palate, but it may also implicate the arms and legs, and frequently it abolishes the power of accommodation in the eye. Sometimes there is anæsthesia, which may, indeed, be more prominent than the motor paralysis. It seems to depend on the poison of diphtheria affecting the nervous system, rather than on gross structural lesions: it usually passes away in the course of a month or two.

Paralysis after fevers likewise occurs. Smallpox, enteric fever, and typhus, are all followed at times by paralysis, sometimes of a wide distribution, sometimes limited to a single limb. Some of these pass away completely under treatment, but others are permanent. In scarlatina hemiplegia, complicated sometimes with aphasia, has been observed; such seizures are due, no doubt, to some gross cerebral lesion, probably the result of thrombosis. In whooping-cough hemorrhagic lesions in the brain, associated with paralysis, have been recorded as rarities.

In *unsteadiness in walking* we must subject the patients to the tests enumerated in the section on this subject (see pp. 222-225), and we must direct our attention to their power of speaking distinctly, to the presence of any of the delusions characteristic of general paralysis, and to any history of insanity in the family. (See Chapter VIII.)

Paralysis of the face may be due to central or peripheral causes. (See p. 203.)

Paralysis of the palate is most often due to diphtheria and to bulbar paralysis. (See pp. 203, 205, 235.)

Paralysis of the speech occurs in many cases of right-sided hemiplegia, in bulbar paralysis, in general paralysis of the insane, and in affections of the ninth and seventh nerves. (See Sections at pp. 225-229.)

NEURALGIA.

Neuralgia, pain in a nerve, requires to be considered as to the exact nerves or branches concerned; the whole of a plexus of nerves, the cervical, brachial, lumbar, or sacral, may be involved. The point of chief importance in considering neuralgia is to see to avoid labelling a pain as neuralgic when there is some other very definite disease merely involving the nerve in a secondary manner.

In neuralgia there is, as a rule, little or no fever; the pain follows the course of certain nerves in a definite manner; although it may, at times, radiate not only to other branches of the same nerve, or to its fellow on the opposite side, but even to branches of completely different nerves. It is usually, if not always, distinctly intermittent, disappearing more or less completely at times; it is sometimes, especially in the facial form, distinctly periodic—coming very regularly at the same hour every day. There are often special tender spots corresponding to the points where the nerve is superficial or passes through openings in the bones or fascia. There is no inflammation, tumor, or other disease present to account for the pain; and further, certain nerves have a special predisposition to such painful affections. The fifth nerve, the sciatic nerve, the intercostal nerves, and the brachial, lumbar, and sacral plexuses are those commonly involved. The viscera may also be affected.

Although the absence of any obvious cause for the pain is an important diagnostic point, it is quite possible that a true neuralgia may be set up by the irritation, for example, of a decaying tooth, of a wounded nerve, or from a twist or strain, from prolonged pressure, an irritating scar, etc. The influence of cold and damp is also potent; this may coöperate with some of the causes just named, as in the case of miners lying for a long time with their legs in a constrained position in a damp part of the workings. Apart from these, which may set up what seems to be a *true* neuralgia, we may have pains of a reflex character; in cases of irritation of the stomach, bowels, ureter, uterus, etc., we often have pains in the head and limbs, which disappear when the irritation passes off. The pain caused by a neuroma or a neuritis, may here be mentioned; there is usually very marked local tenderness in such cases.

In addition to local causes, we must have regard to the general condition, as this is very important in neuralgia. Anæmia in particular is very often responsible for this affection, and various debilitating agencies likewise lead up to it. Ague is an occasional cause of supraorbital neuralgia. The hysterical tendency frequently manifests itself as a neuralgia in various parts, sometimes of a fixed, sometimes of a shifting character. The neurotic constitution, transmitted by inheritance, may manifest itself as a neuralgia in some members of the family. Rheumatism may affect the trunk or the sheath of a nerve, and so give rise to rheumatic neuralgia. Syphilis may operate in a similar way, or it may simulate neuralgia from the effects of syphilitic tumors in the brain or spinal cord. Sciatica is sometimes seen in the course of gonorrhœal rheumatism. Chronic alcoholism may give rise to hyperæsthesia and neuralgia of the lower limbs, simulating at times locomotor ataxy; narcotics sometimes produce similar effects from long habitual abuse.

The greatest care is required in the diagnosis of neuralgia, as numerous blunders are committed in ascribing pains to neuralgia and rheumatism which are of quite a different character. Lumbago, especially in its slighter forms, must be accepted as merely a provisional diagnosis till the kidneys, the urine, and perhaps the uterus and rectum have been examined. Pains in the front of the thigh or along the sciatic nerve, and neuralgic pains in the arms and legs generally, may really be due to serious disease of the bones and joints of the spinal column, the cord, or its membranes; or to abscess, aneurism, and malignant tumors in the abdomen or thorax; intercostal neurlgia can seldom be safely affirmed without repeated examination of the heart and lungs; and an apparent neuralgia of the fifth nerve may prove to be due to cerebral tumor or incipient meningitis, or to some tumor at the base of the skull, or to some less deep-seated disease in the bones of the face.

The influence of neuralgia on the bloodvessels and nutrition is sometimes apparent in the congested state of the affected part, in lachrymation and discharge from the nose, and in the change of color produced in the hair near the affected part. An eruption of herpes zoster sometimes accompanies neuralgia, and in old subjects such eruptions are often followed by violent and persistent neuralgia.

In Bright's disease of the kidney we sometimes have very severe and intractable forms of neuralgia.

In neuralgia the parts are usually kept preternaturally still, and in the facial form a species of tonic spasm may sometimes be noticed; at other times there are twitchings of the muscles. (See convulsive tic, p. 249.)

For some points in connection with paralysis, locomotor ataxy, and neuralgia, see p. 210; for anæsthesia and neuralgia, see p. 200.

Fits of Various Kinds.

The nature of the seizures commonly called "fits" varies so much, and their character is often so obscure, especially to the inexperienced, that a somewhat more general view of such attacks will be given here than is usual in systematic descriptions. This is the more necessary, as the student has frequently to discover from the descriptions given by the patient, or his friends, the true nature of a so-called "fit" before he can estimate its significance in the previous history.

We have then to remember, amongst the possibilities — fainting fits; fits of dyspnœa, associated, perhaps, with angina pectoris, or other forms of cardiac anguish and thoracic pain, leading to more or less obscuration of the intelligence in certain cases; fits with convulsive twitchings of the face or limbs, general, unilateral, or local, with or without unconsciousness (epileptiform type); fits associated with, or followed by paralysis, especially hemiplegia, with or without loss of consciousness; fits with lividity of the face, unconsciousness, and stertorous breathing (apoplectic); fits with simple unconsciousness, without paralysis or convulsion (coma); fits without absolute loss of consciousness, but with agitation, screaming, crying, sobbing, laughing, biting of lips, and occasionally with an approach to convulsions or to coma (hysterical or hysteroid); or similar emotional symptoms associated with distinct convulsions, sometimes tonic, sometimes clonic (hystero-epilepsy); fits with plastic rigidity of the limbs, which are retained in the positions in which they are placed, usually associated with some alteration of the consciousness (cataleptic); fits with tonic spasm of the jaw, or of the muscles of the trunk and limbs (trismus and tetanus); fits with inversion of the hands and feet, or especially of the thumbs, as a principal part of a transient convulsion, or persisting in a comparatively uncomplicated manner for hours or days (carpo-pedal).

In addition to these, attacks of giddiness, of speechlessness, of cramps, of laryngeal obstruction or "crowing," and many others, are sometimes spoken of as "fits," but are usually qualified as to their nature by the patients themselves. Some of these need only be named, as their nature becomes apparent when a little attention is directed to them, either by questioning or observation. Some of them, indeed, chiefly demand attention because of their occurrence under peculiar circumstances, simulating those fits of a nervous nature with which we are chiefly concerned here. Thus a severe attack of thoracic pain or cardiac anguish may lead to much tossing about, with inability to speak, and may ultimately induce fainting and unconsciousness, so that we may be led to think of some convulsive disorder from cerebral causes; or fits of giddiness from various causes may lead to falling down and unconsciousness for a time; or a fit of "crowing" may be complicated with, or pass into, a distinct convulsion.

Fainting Fits (*Syncope*).—We inquire as to the presence of any of the common causes which induce such attacks, nervous shocks, arising from fear, grief, excitement, or pain; the sight of blood, the loss of blood, the want of food and rest, especially with prolonged anxiety; exposure to the close atmosphere of crowded or overheated rooms; the existence of pregnancy; profuse or painful menstruation, etc. Certain persons, moreover, are known to be much more prone to faint than others. The hemorrhage which leads to the fainting may be concealed from view at least for a time. The sudden removal of fluid accumulations in the abdomen, or even the passing of a catheter and the emptying of a distended bladder may cause syncope. Profuse discharges from the bowels frequently do the same. In debilitated conditions the sudden assumption of the upright posture may cause faintness or actual swooning, and in certain forms of weak heart, and especially in fatty degeneration, such attacks are liable to occur without any very obvious cause. In fainting fits the patient has usually some warning of the attack, and the observers may notice a preliminary pallor, or sighing and yawning, or a dreamy expression of countenance; even when these are not present in a pronounced form, the patient has often a sense of swimming, or of faintness, etc., so that in the exent of his falling he is to some extent saved by its gradual character and by those instinctive movements of self-preservation which partial consciousness permits; the element of suddenness often serves to distinguish the epileptic fit from a swoon, even when it is so slight as to be otherwise liable to misinterpretation. The combination of hysterical tendencies in their less pronounced forms, with fainting fits or swoons, may give rise to considerable confusion. In a simple fainting fit the pulse is feeble, the respiration diminished in extent, and the face pale; consciousness is abolished, but not usually so absolutely as in cases of coma. No twitchings occur except, perhaps, as the patient wakes up, and no paralysis precedes or follows the fit.

Convulsion fits are usually obvious enough, and can scarcely escape recognition when the whole phenomena are before us; the difficulties arise from our sometimes seeing only the latter part of an attack, or from the convulsive part being so slight as to evade recognition. In epilepsy, which furnishes the type of such fits, we have usually a premonitory sensation, vision, or internal feeling of some kind (aura); a sudden pallor of the face; a scream; complete unconsciousness; a sudden fall, so that the patient often hurts himself; a series of convulsive movements, affecting the eyes, face, head, neck, trunk, and limbs in the general convulsion. Sometimes the convulsion is unilateral, either throughout or at the beginning of the attack, sometimes the twitching is limited to a single limb, or to the facial muscles on one side. When the convulsion is severe and general, the face becomes blue from the respiratory muscles being involved; the patient frequently foams at the mouth, and the froth is often bloody from the tongue having been bitten in the convulsive movements of the tongue and jaws, or from the intense congestion of the throat resulting from the fit; the convulsion consists of a series of rapid muscular contractions or twitchings (clonic), although certain groups of muscles may remain for a time firmly contracted and rigid (tonic); the whole body may be wriggled about in the violence of the attack. After a few minutes, in ordinary epileptic seizures, the convulsions cease, the lividity begins to disappear, a period of deep unconsciousness with stertorous breathing supervenes, and this merges gradually into a quiet sleep which may be prolonged for some time even after a short interval of restored consciousness. After the fit the patient seems well, although perhaps complaining of a headache, and of a feeling of confusion for a short time, and he may subsequently feel sore and stiff from the violence of the muscular movements. There is no paralysis, or if there be hemiplegia it is usually very slight and quite transient (epileptic hemiplegia). After the fit there is sometimes great excitement, and very erratic conduct with or without violence, and there may be the execution of elaborate automatic actions indicating a deliberate purpose, although quite apart from the controlling consciousness of the individual.

Such are the features of the typical epileptic fit (grand mal); when convulsive attacks, from any cause, approximate to this type, they are called "epileptiform" or "epileptoid;" but nearly every one of the individual features enumerated may be absent, or at least so slight as to escape notice. In particular, there may be no obvious convulsions, a sudden pallor and loss of consciousness being all (petit mal). Allied to this are the so-called "inward fits" of infants, in which we have turning up of the eyes, with apparent unconsciousness, and a momentary rigidity in certain cases. There may, on the other hand, be preservation of consciousness, along with unilateral or localized convulsions; further, the convulsive part of the attack may be over before the patient comes under notice, so that the condition observed resembles simple coma, especially if there be no evidence of struggling, disordered bed-clothes, wetting of the bed, bloody foam, etc. The existence of injury from a fall occurring in connection with a fit rather favors the idea of an epileptic attack or convulsion fit of some kind, as unconsciousness is seldom so suddenly lost in other fits as to prevent some effort at preservation; in some circumstances the marks of injury must make us consider whether the injury, by damaging the nervous structures, may not have determined the convulsive seizure. In apoplectic attacks convulsions occasionally supervene, and in hysteria the discrimination of it from epilepsy is sometimes impossible; indeed a complex condition of hystero-epilepsy is now recognized. (See p. 247.)

The presence or absence of the various features referred to as characterizing a typical attack must be noted. If possible, we should notice or ascertain how the convulsion begins, whether with rotation of the head to the shoulder and conjugate deviation of the eyes, with nystagmus, with twitchings of the cheek and lips, or with convulsion of the fingers, feet, etc Occasionally the convulsion is limited to one side, or even to one limb or one cheek (Jacksonian epilepsy); in such cases we must make sure which side is affected, and if consciousness be not lost we may learn from the patient something of his sensations in the affected part, where they began, and how they extended. In cases with unilateral convulsion, we must try to ascertain whether there was paralysis of the affected side before the fits, or whether it appeared after the convulsion, whether it was transient or whether it persisted for some time. When unconsciousness is not present at the very beginning of a fit, it is important to discover the time at which it appeared, especially in connection with convulsions or sensations spreading up the limbs. It is not always easy to be sure of the preservation of consciousness in a fit; when unable to answer questions we must trust to the appearance of intelligence of the patient when we speak to him, and to his power of afterward describing what happened during the fit, who assisted him, etc.

If the fits recur, we should estimate not only their duration but also the length of the intervals; we should likewise notice whether the muscles become quite relaxed during the intermissions, or whether there remain some tonic spasms; any appearance of an exciting cause must be noted in these recurrences; the determination of the convulsive attacks by some irritation is an important feature in strychnia poisoning.

In connection with such convulsion fits we must ascertain whether the patient has had any attacks before, and at what age they began; epilepsy in its ordinary form usually manifests itself in childhood, or appears about puberty. Any history or evidence of cerebral disease must likewise be searched for; particularly acute or chronic hydrocephalus, cerebral tumors, abscesses, etc. In children we must remember that various forms of apparently slight irritation may cause convulsions; disorders of the stomach from improper food, and diarrhœa are frequent causes of convulsions. In the atrophic and anæmic condition resulting from these or similar causes, we may have convulsions and other symptoms simulating to some extent the course of meningitis; but the history, the diarrhœa, and the collapsed fontanelle serve to guide the diagnosis of this spurious hydrocephalus (hydrencephaloid). The irritation of the gums and mouth during the period of dentition, the presence of worms in the intestines, and indeed anything which tends to produce pain and feverishness, may give rise, *in predisposed subjects*, to general convulsions. Children with rickets and laryngismus stridulus are frequently subject to general convulsions. Acute illnesses (fevers, inflammations of the lungs, and meningitis) sometimes begin, especially in children, with a fit of this kind, and whooping cough is particularly apt to be thus complicated in its course; in hydrocephalus acutus, convulsions commonly supervene at some stage of the illness. In the course of scarlatina, convulsions may be due to the supervention of renal disease. Various poisons are well known to give rise to convulsions. In adults, when there is no history of typical epilepsy, we must consider whether the fits may be due to intemperance and chronic alcoholism, or to syphilis or to Bright's disease. A sudden outburst of convulsions may be the form in which patients so affected may first be laid up. Other forms of cerebral tumor, as well as the syphilitic, may, however, declare themselves in this way. Renal disease may likewise surprise a patient thus who has scarcely ever regarded himself as ill; but usually there has been some history of dropsy, of recent scarlatina, incipient blindness, or some indication of serious disease. The urinary examination is important in such cases; but we must remember that convulsion fits, from any cause, are often associated with temporary albuminuria; the quantity and specific gravity of the urine, and the microscopic examination, by revealing fatty casts and epithelium, may here guide us in recognizing a chronic form of the disease.

Cerebral embolism and thrombosis, certain forms of apoplexy, and senile degenerative changes in the brain, and the congestive attacks in "general paralysis," sometimes reveal themselves by convulsions.

In women during pregnancy and the puerperal state we are apt to have convulsions, depending apparently on irritation, from distention or otherwise, of the uterus, and on the presence of albumen in the urine with all the disorder of the system which this implies. Other forms of irritation propagated from the sexual organs may likewise be mentioned, as causing convulsions; and in particular the premature or unnatural excitement produced by masturbation; ordinary sexual intercourse may determine the occurrence of a fit in those predisposed to such attacks.

FIG. 36 A.

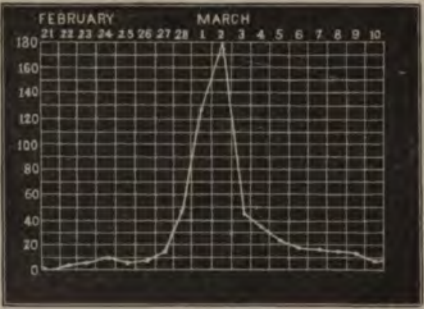
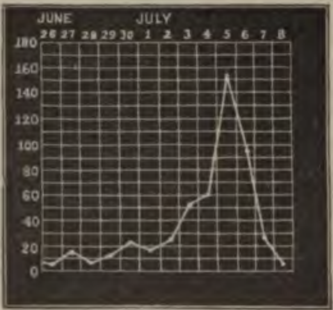


FIG. 36 B.



These two diagrams represent the daily number of convulsion fits in a child who had two great paroxysms, the one in March and the other in the following July. The numbers in the column on the left indicate the fits noted in the twenty-four hours.

Repetition of Convulsions—Status Epilepticus.—It frequently happens that one convulsion is followed by another after the lapse of a few minutes or a few hours: this applies to the regular epilepsy and to all the forms of disease already mentioned as giving rise to convulsions of this type. In this way a patient may be for a few hours almost continuously in fits with short periods of consciousness between them, or with periods of coma between the convulsions. Sometimes, however, the condition is even more prolonged: for many hours we may have almost incessant convulsions, the number being exceedingly great and the intervals between them very short. This is called the "epileptic state," and it may persist for a day or two. Sometimes there is a gradual working up to this state by a marked increase in the number of fits before they become so constant, and in the diagrams here given of two such attacks in the same child it will be seen that the ascent of the curve indicating their daily number, and the acme of the paroxysm was somewhat similar: in the one attack the maximum number of fits was 180, and in the other 155 in the twenty-four hours. (See Figs. 86 A and B.)

This condition is always one fraught with danger to life: the gravity becomes all the greater when very considerable elevations of temperature are also present, as is often the case. There is also danger to the intellectual faculties, and in point of fact the "status epilepticus" is much more commonly met with in asylums than in other forms of practice.

Hysterical fits assume such a variety of forms that only the leading features, or rather the common ones, can be noticed. As a rule, consciousness is not abolished, although there may be changes in this respect, and unconsciousness may be simulated; occasionally, indeed, consciousness may seem to be really suppressed. This test, therefore, although important, is by no means absolute; on the other hand, the preservation of consciousness in local and unusual forms of epilepsy must also be remembered. The emotional disturbance in hysteria is perhaps the most important feature; it is practically confined to the female sex; the rising of a ball in the throat (globus), sobbing, sighing, laughing, crying, and even screaming are quite common. Along with these manifestations there may be tossing about and great agitation, with quivering, twitching, tonic spasm of the muscles, and biting of the lips, so that the movements may bear a certain resemblance to those of epileptic convulsions; but we can usually detect a certain purposive character in the movements, such as clutching at the attendants, and we can sometimes see that they are to some extent under the control of the will, if the patient be firmly dealt with.

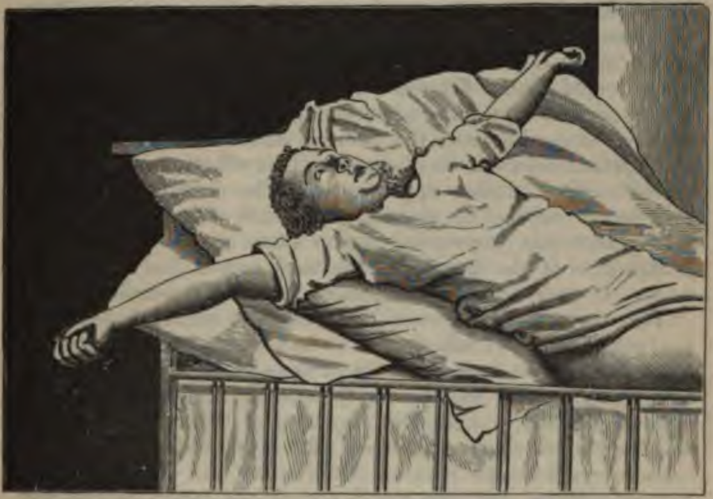
In other cases the movements only amount to a general shaking of the body or limbs, or to quivering of the facial muscles when the patient is doing her best to control herself. Swoonings and brief periods of simple unconsciousness constitute at times the only manifestations of hysteria. There is often in this condition great tenseness of the abdominal muscles and great tenderness on touching the skin. At other times the muscular spasm may give rise to the appearance of general distention of the abdomen or to a localized tumor—both subsiding under chloroform. Or the muscular spasm in the limbs may be more permanent, remaining as a "contracture," with or without paralysis, and lasting for days or months, or even years.

The determining causes of such seizures often supply important information; quarrels, disappointments in love, excitement, grief, vexation, etc., may be named as among the more obvious of these. Disturbance of the sexual organs and functions (disordered menstruation, amenorrhœa, change of life, etc.) are likewise important. In debility from long-continued and exhausting diseases hysterical tendencies may show themselves in patients who had hitherto been able to control such manifestations, so that these attacks may form one of the features of grave disease or of impending death. It is well to remember also that cerebral affections sometimes give rise to symptoms having much resemblance to hysteria; there may be the quivering eyelids when we try to open them; the obedience to commands sharply given after a period in which the patient seemed unable to comply; the refusal of food overcome perhaps by the use of the stomach tube; and even the emotional excitement and self-consciousness so suggestive of hysteria. In all cases involving the least doubt, great care must be taken in forming or at least in acting on any judgment of the case as hysterical.

Plastic rigidity, as found in catalepsy, is closely allied to hysterical fits; in a slight form it may, indeed, be noticed occasionally during such seizures. In its most typical manifestations the limbs and also the neck and trunk may be retained even in the most unnatural positions in which they are placed, or in which they may happen to be when the fit occurs. The arms, for example, may be moulded into various attitudes, and kept in positions not easily maintained even by a muscular man, or the head may be bent back and fixed in such a position that the patient remains resting on the back of her head with the body arched, as occurs in certain cases of tetanus. Such a fit may last for a considerable time, or there may be a succession of such fits, with intervals of a natural condition. In grave forms of such seizures the consciousness is obviously involved, but in slighter cases it is preserved, and the patient may be able to obey commands when stirred up, the movements being then very automatic—every step or every movement requiring the fresh energy of a new imperious order for its performance. Like hysteria, catalepsy may be said to be *almost* confined to the female sex.

Hystero-epilepsy combines some of the peculiarities of the hysterical and epileptic seizures. It is almost limited to the female sex. The attacks come on suddenly and present at times great violence; the movements have often more of a purposive character than in epilepsy. One of the commonest and most striking is the "crucifixion attitude" as described by Charcot. The head is suddenly thrown back, the spine curved, the feet extended, and the patient may rest on the occiput and heels for a time; the arms are also thrown back, somewhat above the level of the shoulders, the hands clenched, and the thumbs turned in. The illustration here given (Fig. 37), obtained from Charcot's Clinque, gives a good idea of the position. To this tonic spasm there may succeed clonic convulsions of various types; a tendency to rhythmical muscular movements is one of the most striking features. Great mental or emotional excitement may be associated with or may follow the attacks, but the remarkable attitudes indicating various passions, as described by Charcot, seldom occur in this country.

FIG. 37.



The crucifixion attitude in the hystero-epilepsy of Charcot. (Bourneville et Regnard.)

In the intervals the patients may be found to present various sensory disturbances—hyperæsthesia of the ovarian region, and hemianæsthesia with color-blindness sometimes appearing suddenly or changing from side to side. Slight irritation of the sensitive ovary may determine a fit, or firm pressure may cause it to cease; the influence of magnets and metals likewise produces remarkable changes, but all these occurrences are probably dependent in large part on the attitude of expectation on the part of the patient.

Local convulsions have already been referred to as sometimes replacing general convulsions in an epileptic fit ("Jacksonian epilepsy"), but the spasms which affect the hands and feet of children must be specially mentioned (*carpo-pedal spasms*). The hands and feet are bent in, the wrists are slightly flexed, and the thumbs are drawn across the palms. This form of spasm is common in infantile convulsions from any cause; it sometimes precedes general convulsions, the spasm in the hands coming or going frequently, or being preserved continuously for some time before the general attack comes on, and remaining after the general convulsions cease. In more favorable cases the nervous affection may never get any further than this local spasm. This affection is often associated with a swollen appearance of the dorsum of the feet and hands, arising in cases of protracted infantile diarrhœa. Along with this carpo-pedal spasm there may be some tonic contraction of the muscles of the back and at the nape of the neck. Consciousness is not usually lost in this condition.

This state is closely connected with the occurrence of general convulsions, of which it is to be regarded as a warning; but a less serious form of spasm in these situations is described under the name of *tetany;* the thumbs are the parts most frequently affected, but the feet may also be involved; the hand and fingers are often contracted into a cone-like shape; in a more severe form the muscles of the trunk and of the jaw may become affected, but the rigidity does not begin in the last named situation as in tetanus. The contraction is not usually very painful, but pain may be caused if an attempt be made to overcome the spasm. It usually varies in intensity from time to time, even when a degree of it remains persistently for days. It has a special tendency to recur after intervals of apparently perfect recovery; according to Trousseau transient spasms may be induced in these intervals by pressure on the nerve trunks. The excitability of the muscles to electrical stimulation is increased. Although most common in children, it affects adults occasionally, especially women during lactation; its frequency appears to be related to climatic influences, and it has been supposed to be connected with rheumatism.

Spasms or cramps in the legs are common in many persons; they often occur suddenly during the night, without any obvious cause, but their frequent dependence on gastric disorders, acidity, etc., is quite certain. Such cramps are very painful while they last. A more general form of the same thing sometimes presents a resemblance to the severer forms of "tetany" as just described. In addition to gastric disorder, we must mention diarrhœa and cholera as giving rise to painful cramps; they are also common in connection with childbirth. Spasms in the limbs also occur, as already mentioned, in connection with cerebral and spinal disease. (See p. 213.)

Local spasms in the region of the face and neck likewise demand attention. Such spasms may be tonic—the contraction of the muscle being steady and sustained—or they may be clonic and twitching in character. Slight tonic contraction of certain facial muscles is found at times in connection with severe neuralgia; the person's face assumes a fixed appearance, as if he were acting a part (*histrionic spasm*). Similar spasms usually, however, more limited to isolated muscles, sometimes remain after an attack of facial paralysis. Twitchings of the face may be the only manifestations of an epileptic fit, and unilateral facial twitchings of the face and neck may constitute the only or chief manifestation of a cerebral lesion.

Sometimes the patient is liable to frequent repetitions of twitchings of the face (convulsive tic); these attacks are not usually painful, but they may be associated with a painful affection of the fifth nerve. Twitchings of the orbicularis palpebrarum have been already referred to. (See "Eye," p. 176.)

Permanent contraction of the muscles of the neck, especially of the sterno-mastoid, gives rise to a form of *wry-neck*. This is, perhaps, usually congenital, and resembles clubfoot so far. Occasionally, however, it appears about puberty, or even later, especially in females, and is generally classified then as hysterical. In such cases it may persist for years. Deviations of the head may arise from rheumatic affections of the muscles of the neck, or from the influence of cold, giving rise to the common form of "stiff-neck" of a passing character. A similar deviation may result from painful glandular enlargements in the neck. Caries of the vertebræ may lead to a lurching over of the head to one side, and disease of the occipito-atlantoid, or axoidal articulations, usually gives rise ta a very peculiar fixity of the muscles of the neck, which become affected in this way simply to preserve the patient from the pain due to the least movement of the head. Deviations of the head associated with ocu'ar paralysis have been already referred to (p. 167).

Twitching of the sterno-mastoid on one side, or of the trapezius, constitutes a most troublesome nervous affection, which sometimes assumes great violence and prevents sleep. These movements are under the influence of the spinal accessory nerve, as shown by the effect (usually temporary) of its section, they are obviously of centric origin, and depend probably on disease at the root of this nerve. This convulsive wry-neck may persist for years in a violent form, or it may assume a troublesome severity only occasionally. The influence of emotional excitement is often very marked, sometimes in the way of greatly intensifying the movements, sometimes in inhibiting them altogether.

Bilateral convulsion of the muscles acting on the head is found in the *nodding convulsions* of children, which sometimes proceed to a bending of the whole trunk (eclampsia nutans, salaam convulsions). Such an affection may be symptomatic of cerebral tubercle, although it also occurs as a more independent disease. (See also p. 216.)

Tonic spasm affecting the jaw (*trismus*) is usually the earliest manifestation of tetanus and of strychnia poisoning, and so must be watched for during the administration of this medicine. *Tetanus* affects the muscles of the back and abdomen as well as the limbs. When the back is affected, so as to be curved backward, the form is named "opisthotonos;" when the abdominal muscles are so much involved as to cause a bending forward, "emprosthotonos" is the name employed; "pleurosthotonos" is applied to similar lateral deviations. Tetanus comes under the notice of surgeons in connection with injuries, but it occurs also idiopathically, sometimes from exposure to cold and wet. The distinctions of tetanus from strychnia poisoning must be sought for in detail in the textbooks; but the tendency to remissions and to exacerbations brought about by irritations of various kinds, constitutes one of the features of poisoning. The early affection of the jaw in tetanus and strychnia poisoning forms a marked contrast with the late development of this symptom in the severe forms of "tetany" already alluded to.

Spasms of deglutition on attempting to swallow, form one of the features of *hydrophobia*. *Spasmodic stricture of the œsophagus* is rare but not unknown. *Spasms of the glottis* as they occur in cases of pertussis, laryngismus stridulus, laryngeal disease, and thoracic tumor are referred to in the section on dyspnœa, etc. (Chapter IX.).

Sudden paralysis is sometimes spoken of as a "fit" or "stroke." In connection with the occurrence of this we must observe, or try to ascertain, whether the paralysis came on suddenly in its maximum extent, or in a series of successive invasions, or whether the advance was marked by temporary or partial recoveries. The exact manner in which the paralysis occurs should be ascertained, so that we may judge of the rapidity of the attack, and of the parts involved, and by such inquiries we are often able to ascertain the presence or absence of consciousness during the seizure. Tendencies to giddiness, flashes of light, noises in the ears, and unusual disposition to sleep, may be inquired about; the friends of a patient can often give important information on these points if the patient himself be unable to do so. If there be unconsciousness we should try to ascertain at what period it supervened, if it did not form the initial symptom, whether it obviously deepened or lightened after it appeared, whether it was associated with stertorous breathing, and whether the face was flushed or livid at the beginning of the fit, or, on the contrary, pale and bloodless. The occurrence of convulsions or twitchings at the onset or in the course of the attack should be inquired for; in unilateral convulsions a paralysis of the affected side may last for a few hours or even for a day or two after the fits.

When a patient is deeply unconscious it is not easy to determine the presence of paralysis; but a certain twist in the features, and a difference at the angles of the mouth, often serve to reveal a one-sided paralysis. On lifting or moving the limbs we may be able to discover a distinct difference in the flaccidity of the two sides, and we are often able to observe that any restless movements of the patient are confined to the limbs of the one side. Attention must be directed in the further examination to the state of the heart and blood-vessels (rigid arteries, hypertrophy or valvular disease of the heart, etc.), to the state of the kidneys, and to the previous history of any former attacks. The immediately preceding events are also important, exposure to the sun, the possibility of injury to the head, the presence of excitement, the facts as to eating and drinking, etc. (See section on "Paralysis," pp. 208–209.)

Coma has already been referred to as a frequent accompaniment of paralysis and convulsion. Unconsciousness likewise occurs in simple fainting fits, and forms one of the less common manifestations of hysterical attacks, and of the rare conditions known as catalepsy, mesmeric trance, etc.

But coma may exist apart from such complications. As explained under the section on convulsion and sudden paralysis, it is not always easy to say whether the comatose state has been complicated by these; indications for the discrimination are given under these headings. but with regard to paralysis we have often to wait till the coma passes away before we can judge: with regard to convulsions we may remain in doubt unless there be a repetition of them. Moreover, even in a fit, essentially of an epileptic character, the convulsive part may be absent, as already remarked.

Many diseases terminate in coma lasting for some time before death, and coma forms a frequent episode in febrile diseases which are attended with delirium. In such cases we have usually a series of symptoms leading up to the comatose condition, preparing us, as it were, for its occurrence.

When occurring suddenly, apart from any manifestations of nervous disturbance, or when developed rapidly, even in the midst of nervous symptoms, it calls for consideration under the present section. The most striking form of this sudden coma occurs in renal disease, the nervous complication taking the form of uræmic coma instead of convulsion. It may supervene without warning, and after lasting for a variable period of hours or days, it may pass off suddenly and completely without leaving any apparent effects. We must in such cases test the urine with care; it may be worth while even to draw off some with a catheter for the purpose. We should also, if possible, ascertain to what extent urine had been passed for some days before the fit,—whether it was deficient in quantity or quality. We inquire also for any history of dropsy, or other evidence of renal disease, dimness of vision, or the like. In renal coma the pupils are usually moderately contracted, or at least not dilated; and the temperature is not elevated; it may even be low. The test for ammonia in the breath, by means of its action on the fumes of a drop or two of strong hydrochloric acid placed on a glass rod, is not very satisfactory; adaptations of Nessler's test solution have likewise been tried, but not with much success.

Very different in most respects from this is the coma found at the violent onset of scarlet fever, measles, and some other specific fevers. The coma in such cases attacks children especially, after a short period of delirium and excitement, in the midst usually of a high fever. In such cases the diagnosis is often enveloped in much obscurity, owing to the absence or suppression of the rash, and the true nature of the attack may only appear on the subsequent occurrence of some fever in other inmates of the house.

The whole group of poisons classed as narcotics produce coma or unconsciousness. Of these, the most important is opium. This may cause coma in certain cases when administered even in medicinal doses, especially in renal disease, and in some forms of cerebral disorder. Extreme contraction of the pupils is an important indication of opium poisoning, although found in other forms of coma due to cerebral disease. (See p. 171.) Chloroform, chloral, and alcohol must also be remembered; the diagnosis of unconsciousness from alcohol as distinguished from cerebral disease is often difficult; the smell of the breath is important, but sometimes misleading, as those who feel ill may have resorted to the use of spirits on that account just before the seizure.

In nearly all cerebral diseases coma plays an important part; it may be associated with convulsions and paralysis, or it may occur alone. It is often due to pressure on the brain from depressed fracture and from hemorrhage, so that in traumatic cases the coma comes on after the injury in a gradual manner. Or the pressure may arise from fluid in the ventricles, from meningitis, or from cerebral or meningeal hemorrhage. Tumors, abscesses, thrombosis, and other forms of disease in the brain, often give rise to disturbances manifesting themselves in coma which may be transient, although the cause may be permanent.

TWITCHING OR CHOREIC MOVEMENTS.

Twitchings or clonic spasms have been mentioned in connection with paralysis (p. 214), but they also occur independently in the form of disease termed chorea. The movements are erratic, and are specially developed when the patient attempts to perform definite actions, such as raising a spoonful of fluid to the mouth,—the limbs refusing to obey accurately the impulse of the will. Even while sitting quietly, twitchings in the face and limbs occur, and these are aggravated on attention being directed to the patient. Grimaces, from twitchings of the mouth and eyes, are the commonest forms of the early manifestations of this affection. A good test in chorea consists in getting the patient to hold out a stethoscope at arm's length on the palm of the hand, to pick up a pin with one hand and put it into the other, or to keep the arms steadily at the side while standing or walking, or to keep the tongue protruded for a little time. The restless tossings in bad cases are so extreme that the patient can scarcely be kept in bed or prevented from hurting herself by the movements. Speech and even deglutition are affected in the more serious forms. One side is often much more involved than the other, and sometimes is affected alone (hemi-chorea). Complications with paralysis have been already referred to (p. 214). A slight weakness of mind and flightiness are common in chorea, and may often be traced even after the twitchings have ceased; sometimes the defect is very pronounced, associated with speechlessness, incontinence of urine, and other alarming symptoms, but it very rarely leaves any permanent disorder of the mind.

Chorea is most common in children of about seven to twelve years of age, especially in girls, but it also occurs about puberty, and during pregnancy, sometimes in those previously affected. There is, indeed, a special tendency to relapses or recurrences of this disease; these are most often developed in the winter or spring months. We must have regard to the general state of the children, particularly as to anæmia and constipation. The disease is to some extent hereditary, or at least included in a general family tendency to rheumatic and cardiac affections, which seem to have some affinity with chorea. Not unfrequently we find chorea following cardiac disease due to rheumatism, but occasionally the chorea complicates the acute stage of rheumatism, it sometimes precedes it, and often occurs independently of it. The heart must be examined in choreic patients; systolic bruits are not uncommon, but many of these pass away, and are evidently not due to valvular disease; some may be hæmic in their origin, and some due to disturbed muscular action in the heart itself. Scarlatina has also a tendency to develop chorea. Many facts point to the connection of chorea with cerebral embolism and thrombosis. The determining cause is often supposed to be some fright, but this has probably been much exaggerated by the public, the child being easily frightened because of the illness beginning. When high fever exists with chorea, the case assumes a more serious aspect; sometimes the pyrexia is due to endocarditis or rheumatic complications.

Local forms of chorea seem to belong to a different form of disease. (See "Local Spasms," pp. 176 and 249.) Sudden twitchings affecting the whole body, or certain portions, with lightning-like suddenness are described under the name of "electric chorea;" this disease has little affinity with ordinary chorea, being more allied to hysterical affections or "spinal irritation."

DELIRIUM.

Delirium is always a sign of nervous disturbance, but it may arise merely from a general affection of the whole economy operating on the nervous system. In high fever from any cause and in long protracted febrile states with much debility delirium is extremely common, so that a certain disturbance of this kind is habitual just before the fatal termination of an illness. The slighter forms of febrile delirium show themselves when the patient is half asleep, or before he is properly awake; the talking, as if in sleep, is continued probably in connection with the previous dreams, even when the patient awakes so as to speak or to answer the attendants. In the slighter forms of this "wandering" or "wavering" the patient catches himself up very quickly, and knows that he has introduced the confusion of his dreams into his conversation. In deeper forms of delirium the patient fails to recognize any error, and may go on speaking, or contending, or struggling with the attendants, as if they were the enemies conjured up in his dreams. Although the patient fails to recognize those around, a certain recognition may remain, and may suggest resemblances or reminiscences from an association of ideas which we can sometimes trace. In yet deeper forms of delirium the external world is less recognized, and the patient shouts, screams, or sings, quite irrespective of what the attendants do or say. In these last two forms the patient has often a tendency to rise up and get out of bed, probably with the notion of escaping from something disagreeable. Another form of delirium is characterized by low muttering, or by the movement of the lips without much sound, varied at times by a few louder words, but without, as a rule, any great excitement or disturbance. Picking at the bed-clothes, drawing out imaginary threads, and waving motions with the arms, are not uncommon in this state. (Compare p. 36.)

All these forms of delirium are common in the specific fevers and in severe inflammations, very specially in typhus fever and severe scarlatina, in inflammation of the lungs, and in meningitis. In pneumonia its onset is sometimes very sudden and so unexpected as to be liable to lead to accidents or to raise the suspicion of insanity. The influence of intemperate habits, or of the habitual use of stimulants, is very potent in causing or increasing the delirium of fevers and inflammations, and a mobile nervous system and great mental activity likewise tend in the same direction. Some of these forms of delirium are found in various forms of injury to the skull and disease of the brain, in intoxication from alcohol and chloroform, and in the poisoned state of the system known as uræmia. It occasionally happens that delirium breaks out violently after the crisis of a febrile illness, having up to that time been but slight in character. This can sometimes be explained by the previous intemperance of the patient, but oftener perhaps by anæmia of the brain resulting from a prolonged fever, or by the circulation of effete matters in the system, poisoning the nervous centres, as in uræmia.

Delirium differing considerably from the foregoing is common in delirium tremens. In this disease the patient is affected with delusions and illusions, and is often very suspicious. He is usually full of business of some kind in his delirium, driving horses, hurrying off to the station, etc., and seems to see various objects distinctly, to which he calls attention; he addresses strangers as well-known friends, with whom he has had appointments, and gives long accounts of circumstances and transactions which are essentially imaginary, although mixed up with actual facts and correct names. Sleeplessness and trembling are usually present. The patients often are terrified by the vision of mice and rats, and even more dreadful forms supposed to resemble demons. The delirium here referred to, although due to the chronic use of alcohol, is, of course, quite distinct from the forms of mental disturbance from recent excesses. The illusions produced by certain other poisons or medicines, especially hyoscyamus, may be mentioned here. Belladonna also gives rise to delirium and excitement, and opium and chloral in doses inadequate to procure quietness for the patient often produce or intensify the excitement. Salicylic acid and its compounds sometimes produce maniacal delirium.

When delirium is mixed up with unmanageable conduct and violence, we speak of it as mania or maniacal delirium. It may be merely an exaggeration of the delirium already described as symptomatic of fevers or of inflammations, etc., but it may arise apart from these as one of the forms of insanity. It appears likewise, occasionally, after epileptic fits, or even in cases essentially of this nature, in which no proper fit is observed (epileptic mania). Mania likewise appears after childbirth in various forms (puerperal mania), sometimes with its usual violence and excitement; there is often a tendency to deeds of violence, not only as regards the patient herself, but more especially as regards her infant. In its further progress it may settle down to a melancholy which may indeed be its leading characteristic from the beginning, and if much prolonged it is apt to tend to dementia. (Compare the sections on epileptic, puerperal, and other forms of mania, etc., in Chapter VIII.)

VERTIGO.

Vertigo, or giddiness, and a sense of swimming, or of undulating motion, must be considered as to whether the sensation is felt by the person within himself, or whether external objects seem to whirl or move. We may try the effect of closing the eyes as a test of this. Both forms may occur separately, or they may be combined. A further point of distinction is whether the person is perfectly conscious of the fallacious character of his sensations, preserving his power of reasoning correctly, or whether with the vertigo his whole mind becomes confused. The usual character of the motions experienced is that of whirling round either slowly or quickly; but sometimes the movements seem even more strange, articles appearing to be piled up on the top of each other, or even turned upside down. In slighter forms there is only the sense of heaving up and down, or from side to side, as if on board ship, or on a suspension bridge which sways under our feet. Physical conditions of this kind may indeed give rise to vertigo lasting for a longer or shorter time, and rapid rotation and swinging are well known as determining vertigo in those unaccustomed to these motions.

Vertigo appears not unfrequently in connection with slight derangements of the stomach and liver, and may be associated with other evidence of digestive disorders. It may thus appear after alcoholic excesses as well as during the stage of intoxication. The use of tobacco by those unaccustomed to it, or habitual excess in others, may likewise occasion vertigo. Nervous excitement in many forms, anger, fear, and the presence of unaccustomed surroundings, give rise to sensations of this kind, when, as we say, the person does not know "whether he is on his head or his feet."

A form of *stomachal vertigo,* of great suddenness and severity, may be recognized in certain cases where there is not much evidence of gastric disorder, the name being derived from the obvious effect of treatment directed to this organ, especially by the use of alkalies, tonics, and nourishing diet. The vertigo in such cases is often very violent, rendering progression quite impossible, and not prevented by closure of the eyes. With this there may be associated the idea of a yawning abyss at the feet, but the patient is usually able to argue correctly as to these illusions. Persons who have had such attacks are liable to their repetition. (*Vertigo a stomacho læso.* Trousseau.)

Vertigo, associated with deafness or noises in the ears, forms a leading feature of "Ménière's disease," arising from affections of the labyrinth or semicircular canals; but similar results may follow from pressure on the labyrinthine fluid from various causes. (*Vertigo ab aure læsa.* See "Ear," p. 189.)

A form of vertigo which is liable to be misinterpreted is that which is due to weakness or paresis of the ocular muscles, occurring especially in persons with an abnormal state of the refraction of the eyes. Such paresis, which may not give rise to any obvious squint, although there may be diplopia, is apt to produce some apparent deviation of the objects looked at, and it gives rise to erroneous impressions of the position of objects from the unusual force exercised in adjusting the eyes. Vertigo due to such causes ceases when the eyes are closed, or when the one affected with paralysis is shut. (See p. 169.)

Vertigo from cerebral congestion, or in connection with an impending apoplectic attack, usually appears with pain in the head, sickness or nausea, and other cerebral symptoms. Such vertigo may be rendered worse by a full meal, or by dyspeptic disorders, so that we must not set down this symptom exclusively to the stomach on that account. In a person over fifty affected with vertigo, especially if somewhat persistent although not very violent, we must be on our guard against apoplectic attacks, particularly if numbness in one side, or other indications of brain disease, are likewise present. Attacks of vertigo in an extreme form are often present in cases of cerebral tumor, and perhaps more particularly of cerebellar disease. The vertigo may, in some cases, account for the staggering found in such cases, but is not always associated with it. This vertigo may lead the patient to think he is falling off the bed when he is lying safely enough, and it may exist in cases where blindness has occurred and where ocular causes are thus excluded. Vertigo likewise constitutes a "warning" in some cases of epilepsy, or may be the chief part of an attack (epileptic vertigo).

Disturbance of the cerebral circulation is probably a very common cause of vertigo, even when this is brought about by reflex irritation from the stomach. Such disturbances may also arise in feeble persons, or after fevers, etc., on suddenly raising the head. A certain approach to this vertigo is common on getting up for the first time after a long illness with confinement to the recumbent posture, or on going out to the street for the first time. Vertigo is likewise a common incident in cases of loss of blood in large quantity at one time or in small quantities for a long period, and for similar reasons we find it in profuse or chronic diarrhœa, or it may appear after these, in the event of the patient rising or sitting up. Allied to vertigo from anæmia due to hemorrhage, is the giddiness observed from more chronic deteriorating causes, overwork, deficient food, prolonged lactation, menorrhagia, leucorrhœa, etc. Occasionally vertigo results from an apparently opposite cause—the stopping of some habitual discharge.

The onset of the specific fevers and acute inflammations is often characterized by vertigo, and the state of the system known as uræmia may likewise give rise to this symptom. The influence of alcohol and other poisons may be compared with these poisoned states.

SLEEP AND SLEEPLESSNESS.

Various disorders in the patient's sleep must be inquired for and noted when present. There may be sleeplessness, or undue tendency to sleep, or the sleep obtained may be disturbed or troubled.

Sleeplessness may be due to accidental disturbances, such as change of residence and unusual surroundings, or removal to hospital, and the like. Again, it may be due to anxiety or unnatural excitement and activity of the mind before withdrawing to rest, and many other similar disturbances; these operate much more powerfully on some people than on others. Pain is a fruitful cause of want of sleep; this pain may be connected with the disease under which a patient labors, or it may be, as it were, accidental—from an attack of toothache, etc. Dyspnœa and orthopnœa may interfere with sleep, owing to the inability of the patient to lie down or to keep in one position. Patients with serious cardiac and renal disease affected in this way can only obtain brief snatches of sleep, and may be seen nodding off continually into momentary slumbers, as they sit up or lean their heads forward; it may be added of some of these patients that as they are never properly asleep, so they are seldom thoroughly awake: they sometimes awake with such feelings of alarm that they are anxious to avoid sleep. (See p. 39; see also Chapter IX.)

Highly febrile states are usually adverse to natural sleep: this arises partly from the attendant restlessness and irritability which, instead of getting less with the approach of night, tend rather to increase; the presence of sweating, and the discomfort associated with it when profuse, are apt to aggravate such a condition. In these cases the patient, worn out with restless tossing about during the night, may obtain some sleep about four or five in the morning, as the daily remission of the fever becomes established. High fever and delirium combined are very adverse to sleep, and may prevent any sleep for many successive days and nights. The diseases in which this is most marked are pneumonia, typhus, and delirium tremens, but it occurs in a multitude of other diseases. Patients who are intemperate in the use of stimulants, and those also whose minds are usually very actively employed, either from their natural disposition or from the character of their occupations, are apt to suffer most from this complication in such diseases.

Mania, melancholia, and various forms of mental disorder, even in its slighter manifestations, are often associated with, and sometimes preceded by, marked insomnia: it often seems to the patient's friends as if the mental derangement were due to want of sleep. Those affected in this way may have two or three hours' sleep in the course of the night, but it is almost invariably during the very first part of the night that they sleep, after which they lie awake, and rise up in the morning in the very depth of their misery. This contrasts with the sleeplessness arising from worry and anxiety which often keep the victims awake for some hours, but allow them to sleep as the morning wears on. When sleep is procured by narcotics in cases of insanity, the patient often awakes from a long sleep as wretched as if he had lain awake, or even more so. The period of misery after a sleepless morning is a favorite time for suicidal tendencies to manifest themselves.

Sleeplessness is often an early indication of an impending attack of delirium tremens and one of the most persistent symptoms during its continuance. Chronic sleeplessness may sometimes be attributed to the abuse of alcohol; in such cases, as in regular insanity, the person may sleep in the early part of the night, remaining awake after two or three in the morning. The habitual use of opium, of chloroform inhalations, and of chloral, begun perhaps to procure rest, is very often responsible for the persistence of an aggravated form of utter sleeplessness which large doses of these drugs may be quite unable to overcome, although the want of them may intensify for the time the patient's misery. A somewhat similar form of sleeplessness, however, may be found in hysterical patients and others troubled with "nervousness" in various forms quite apart from the use of such drugs or of alcohol.

Disturbance of the sleep by a rapid succession of ideas, or by a whirl of incongruous or disagreeable visions, is frequent in the slighter forms of delirium, and it also occurs sometimes in those whose brains are overtaxed. Such sleep may leave the person with a feeling as if he had been more busily employed than while awake, and does not afford any sense of rest. Effects of this kind are sometimes produced by the medicinal use of opium and other sedatives, especially when administered in unsuitable cases or in too small doses. Dreams of terror which overtake the patient whenever he goes off to sleep, and from which he awakes bathed in cold sweat, are common in deep-seated suppurations, disease of the bones, and other serious affections associated with hectic fever. These dreams are sometimes so terrible that the patient struggles against the approach of sleep. Less alarming or at least less persistent forms of this disorder are found in "nightmare" produced usually by a meal still undigested of which the person had partaken shortly before sleeping. Slighter forms of this disturbed rest are very common in various dyspeptic disorders, and also in functional derangements of the liver.

The "*night terrors*" which cause children to waken up and scream in a scared manner, quite unconscious apparently of the presence of their parents or attendants, depend probably on the vividness of their dreams, which are not dispelled by the sight of well-known faces.

Somnambulism or night-walking, in its milder forms, is not uncommon in children as a very occasional event, but it continues to occur frequently in some even till adult life is reached;

it is commoner in females than in males, and indicates a sensitive or overwrought nervous system.

Undue tendency to sleep is sometimes met with, especially in children, as an early indication of the action of the specific fevers, scarlatina and enteric fever in particular. It is an important symptom in various head affections, in the later stage of meningitis for example, and in other forms of disease characterized by pressure on the brain. In adults with a tendency to apoplectic attacks, undue sleepiness and an invincible disposition to go to sleep, especially after meals, supply important warnings of an impending attack.

Great tendency to sleep is likewise a feature to be watched for carefully in renal disease, as it frequently indicates the approach of uræmic poisoning, and may be the precursor of convulsions or other serious accidents; in this condition and also in brain disease small doses of opium may produce alarming effects.

A certain tendency to undue sleepiness occurs in some cases of anæmia, from various causes; a form of this, occurring in children, sometimes simulates hydrocephalus (spurious hydrocephalus, hydrencephaloid). This form of disease is usually associated with diarrhœa; convulsions may supervene and perplex the diagnosis even more. The flattened fontanelle, the previous diarrhœa, and the pallid complexion are important points in the recognition of this condition.

Exposure in cold air determines a tendency to sleep and aggravates the danger arising from the drowsiness induced by drunkenness. When sleepiness becomes extreme, so that the patient can scarcely be roused, we approach the condition termed coma. (See p. 252.)

HEADACHE.

In studying cases of headache we must try to separate all the more superficial pains and forms of disease, such as neuralgia and toothache, and also the pains due to rheumatic affections of the face or head, glandular and other swellings in the neck, and affections of the bones. Sources of pain of a deep-seated character exist in inflammation of the jaw, or of the roots of the teeth, and in inflammations of the tympanum, of the iris, of the eyeball, orbit, etc. In the case of those able to express their sensations we are often guided aright by their description of the locality of the pain, but when we have not this assistance we are apt to be at a loss in cases of this kind.

Careful testing by pressing, and if need be by probing, the individual teeth and gums, trying the various spots where the nerves are superficial for the tenderness so common in neuralgia, pressure in the vicinity of the ear, an examination of the eye, and moving the head in various directions—all these may often guide us in our search for the cause of the pain.

Quite distinct from these various pains, headache is found in the early stage of many fevers and serious inflammations; when delirium comes on, the headache disappears. Headaches also occur very frequently in cases of digestive disorder, in various nervous affections, especially in hemicrania or "sick headache," and in many serious lesions of the brain and its membranes; headache likewise occurs from overwork and prolonged mental strain, in the poisoned state of the system known as uræmia, and in anæmia from prolonged suckling, leucorrhœa, or other exhausting disorders. The effect of strain on the eyes, from excessive use or more particularly from errors in their refraction, must likewise be remembered as a frequent cause of headache. (See p. 175.)

In the investigation of headache, the presence or absence of pyrexia is most important; when this is ascertained to be really absent by means of careful and repeated thermometrical observations, we may eliminate at once the group of the fevers and many of the internal inflammations.

The association of headache with sickness and vomiting, is very frequently observed in the most diverse forms of the affection.

In *febrile diseases* the two symptoms go together, both being produced by the same cause, although often the whole illness is, at first, ascribed to digestive disorder: the furred state of the tongue may favor this error. In such cases the headache is usually general.

Sometimes it is quite plain that errors in eating and drinking have determined a *gastric catarrh or a disorder of the liver:* this often leads to severe headache, which tends to be chiefly frontal, or it may also involve the back of the eyes.

In other cases, of *nervous origin*, the headache may seem to determine the vomiting: in brain disorders, vomiting often supervenes without any obvious gastric cause, or even without any relationship to the taking of food, and perhaps with no disorder of the tongue, at least at the first; as the case goes on, especially if due to inflammation of the membranes, the tongue may become extremely foul. In the unilateral headache of *migraine* the nervous disturbance often shows itself at first in disorders of vision, as in spectra of various kinds, and then in pain on the side of the head opposite to the affected eye. Patients with this disorder are liable to recurrences of the headaches: sometimes the pain varies from side to side in different attacks, but usually it shows a preference for the right or the left. After the headache has increased in severity for a few hours, violent sickness, retching, and vomiting, supervene; the patient cannot raise the head without much aggravation of the suffering; this is also increased by exposure to light. After lasting for some hours, or for a whole day, or even two days, the nervous disturbance passes off. This "sick headache" is often due to heredity; other more ordinary forms of headache, particularly in *hysterical subjects*, seem also to be part of the neurotic inheritance—part of the peculiar liability to nervous disorder which may assume many forms, and give a troublesome persistency to this symptom. Headache, with vomiting and giddiness, may indicate *grave disorders in the bloodvessels and circulation* of the brain, with a tendency to apoplectic attacks: in such cases the headache is often occipital, sometimes vertical.

Headache, with some sickness and giddiness, may also arise from sympathetic disturbance reflected from the digestive organs, or due to *irritation of an ovarian and uterine character* (with dysmenorrhœa, etc.); the sexual organs in the male may, in the same way, be responsible for headaches of this type. The age of the patient, the state of the arteries, and the other circumstances of the case may guide us in the discrimination of these from cerebral cases. Headaches due to congestion of the brain are usually made worse by any approach to stooping, and the patient may often be seen to keep his head as high as possible; in addition to active congestion, such as may be associated with apoplectic tendencies, headaches may be due to *passive congestion*, as from heart disease, etc.

The headaches of exhaustion may be due to *overtaxing the nervous energy* by study, prolonged anxiety, or fatigue, especially when conjoined with unfavorable surroundings. Headaches often arise from *anæmia with imperfect nutrition of the brain tissue* from want of suitable nourishment or inability to digest such food as may be taken; similar impoverishment may be brought about by long-continued losses of blood from the bowel or womb, and by prolonged discharges of any kind, by overlactation, or other similar drains on the system.

The influences of *impure air*, as from overcrowded rooms in school or workshop, imperfect bedroom accommodation, or the contamination of *sewer gas*, may greatly aggravate many forms of headache, or they may of themselves give rise to such disorders. Not unfrequently various combinations of these influences are at work, as in the case of children with a naturally eager temperament, badly nourished at home, overtaxed with studies, and exposed to impure air in the school.

Poisonous matters circulating in the system from imperfect elimination of urea in renal disease may give rise to the form of headache known as uræmic, and this may exist and may point to grave danger without any very notable diminution in the urinary excretion. But in Bright's disease we may have headaches from increased arterial tension, or from some of the forms of intractable neuralgia occasionally found associated with it; at other times, the headache of Bright's disease may be associated with hemorrhagic and other changes in the retina, and so becomes closely allied to the headache of arterial degeneration, liable to result in apoplectic attacks. Prolonged constipation may give rise to headache, possibly due in part to the undue retention of effete matters in the bowel, and to that extent it comes within the class of toxic headaches. Many poisons, including some taken as food, drink, or medicine, may give rise to headaches of this class, particularly when special idiosyncrasies are kept in view.

In grave *structural disease of the brain*, of the base of the skull, and of the membranes, we have a fruitful source of severe and persistent headache; meningitis, affecting the hard and soft membranes, and other forms of inflammatory disease, abscesses, tumors, hemorrhages, embolisms, softenings, all give rise at times to this symptom. With these may be classed the deep-seated and unbearable headache of *syphilitic disease*, sometimes due to ostitis or periostitis, and at other times to disease of the brain itself: these pains frequently present a marked tendency to nocturnal exacerbations. The headache of *sunstroke* may also be referred to, although the nature or existence of structural lesion may not be very clear: headache may not only occur at the beginning of the sunstroke, but may persist for months or years afterward. In all the cases enumerated above, we usually have more or less sickness and vomiting, or at least nausea, when the pains are severe: exceptional cases, however, not unfrequently occur where the most intense headache due to meningitis, for example, may not be complicated with vomiting from first to last.

In the study of cases of headache, the detection of paralysis of certain cranial nerves, the examination of the organs of sense, the existence of vertigo, noises in the ear, or flashes of light, may help the diagnosis. The occurrence of disorder in the cerebral functions, of delirium, excitement, or insensibility; or the supervention of local paralysis, hemiplegia, or convulsions, frequently point to the cerebral nature of the disease.

PAIN IN THE BACK.

This symptom, like headache, occurs at the beginning of many of the specific fevers and some of the acute inflammations. It is very specially prominent in the case of smallpox. In rheumatic affections pain in the back is sometimes a very marked feature of the complaint, but other joints also usually show some indication of pain and swelling. In disease of the spinal cord, and more especially in spinal meningitis, there is often pain in the back, although it may radiate in various directions, giving rise to a general "hyperæsthesia." Pain in the neck, often associated with retraction, is a notable feature in cerebro-spinal meningitis, although it occurs in cerebral meningitis also. Pressure over the various vertebræ, and the effect of heat and cold to the spine, should be tried in such cases. The sense of constriction, as if by a cord, is likewise common in spinal diseases. (See p. 201.)

Pain in the lumbar region is often designated "lumbago;" such an affection may be rheumatic, gouty, or neuralgic. Many cases, however, carelessly set down as lumbago, are often due to much more serious ailments, especially to disease of the kidney, renal calculus, etc. Affections of the bladder also sometimes give rise to pain in this situation. Pain in the lumbar and sacral region is a very common feature in inflammations, flexions, and various affections of the womb, or other disorders of the female organs. (See Chapter XV.)

Caries of the vertebræ, with or without incipient abscess, and aneurism of the aorta are frequent sources of severe and intractable pain of a most puzzling character, as the pain may exist for a long time before definite evidence of their presence can be ascertained: malignant tumors may also cause pain for a long time before their presence can be recognized. Careful search, however, should be made for indications of these diseases, and the possibility of their presence must be remembered in obscure cases.

AUSCULTATION AND PERCUSSION OF THE HEAD.

Auscultation of the head has been practised chiefly in the case of children. A systolic bruit may often be thus heard in infancy: but it is now quite certain that its presence is of no importance in the diagnosis of meningitis or hydrocephalus. It seems, indeed, to be more frequent in rickets than in any other condition, the unclosed fontanelle having probably more to do with the phenomenon than anything else: anæmia, however, has been supposed to be a determining influence also.

The stethoscope may be applied lightly over the fontanelle in this examination: or a towel or handkerchief may be applied to the infant's head and direct auscultation practised without risk of hurting the child. The student must remember that respiratory sounds are transmitted sometimes very loudly to the ear of the observer during such auscultation, as well as various other adventitious sounds.

Percussion of the skull has been of late years practised with some advantage. The point of the finger is made to strike the skull somewhat sharply in various regions: symmetrical spots are selected for the sake of comparison, and of course as nearly as possible the same force must be used in making the strokes. It is found that in some lesions of the brain, particularly in those of limited extent involving the cortex or membranes, a very distinct area of tenderness can sometimes be made out. This may guide the diagnosis, and in conjunction with localized motor or sensory disturbances may assist us in defining the exact locality of the lesion: as already stated, it may also afford us some indication of its superficial character.

In the study of this method it is essential, especially in view of any proposed operations, that an accurate idea be formed as to the position of the convolutions, and in particular of those which concern the movements of the face and limbs. Ordinary anatomical works, even when the convolutions are delineated in relation to the sutures, afford only a vague guide to the clinical inquirer, as the sutures are of course usually quite hidden, and the variations in form of individual heads are considerable. An important contribution to the definite localization of the convolutions has been made by Dr. Robert W. Reid, who gives detailed directions for the measurements required on the living subject.[1]

The practice of this method of ascertaining the presence of tenderness on percussion has brought out certain alterations in the *sounds* thus produced. Dr. Wm. Macewen has called the attention of the writer to this subject, and it seems quite certain that in cases with considerable effusion in the ventricles, usually with enlargement of the head, a peculiar quality of percussion sound is obtained in the case, for example, of children with cerebral tumors. The alteration is not always equally marked on the two sides. How far these alterations are due to distention of the cavities of the brain and thinning of their walls, and how far to changes in the bones, cannot as yet be formulated: the method seems, however, worthy of notice here as a guide to its further study.

The list of works enumerated here should be supplemented by many of those mentioned in last chapter on the organs of sense and by some of those which will be found at the end of Chapter VII. on electrical instruments; in particular, the great work of Duchenne, De l'électrisation localisée, 3e éd., Paris, 1872: portions of this have been translated by Dr. Poore for the New Sydenham Society, London, 1883. For books on insanity and general paralysis, see Chapter VIII.

Ross (James), Treatise on the Diseases of the Nervous System, 2d ed., 2 vols., London, 1883: this edition is of special value, as it gives copious references to the literature of the subjects discussed: but the work is also issued in an abridged form in one volume: Ross, Handbook of the Diseases of the Nervous System, London, 1885.—Ziemssen's Cyclopedia, vols. xi.–xiv., London, 1876–78, contains a series of very important articles; for example, on "Diseases of the Peripheral Nerves and of the Spinal Cord," by Erb, and on "Disturbances of the Speech," by Kussmaul, etc.—Reynolds's System of Medicine, vol. ii., 2d ed., London, 1872, contains the articles on nervous disease.—Trousseau, Clinical Medicine, vol. i., as issued by the New Sydenham Society, London, 1868, contains his lectures on nervous diseases: these may be recommended to the student as extremely interesting clinical descriptions, although, of course, now somewhat antiquated in their pathology.—Quain's Dictionary of Medicine, London, 1882, may be consulted for short articles, usually of much value, on special nervous diseases.

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[1] "Observations on the relation of the principal fissures and convolutions of the cerebrum to the outer surface of the scalp."—Lancet, September 27, 1884. One of his diagrams is reproduced in Dr. Stirling's translation of Landois's Physiology, vol. ii, p. 934.

In addition to the above cyclopedic works, the following deserve special attention: Gowers (W. R.), Lectures on the Diagnosis of Diseases of the Brain, London, 1885: The Diagnosis of Diseases of the Spinal Cord, 4th ed., London, 1884: Epilepsy and other Chronic Convulsive Diseases, London, 1881: Pseudo-Hypertrophic Muscular Paralysis, London, 1879: Medical Ophthalmoscopy, 2d ed., London, 1882: A Manual of Diseases of the Nervous System is also announced as in the press.—Charcot (J. M.), Lectures on Diseases of the Nervous System, New Sydenham Society, 2 vols., London, 1877–81: Lectures on the Localization of Cerebral and Spinal Diseases, New Sydenham Society, London, 1881: Iconographie de la Salpêtrière (Bourneville), Paris, 1876–81.—Wilks (S.), Lectures on Diseases of the Nervous System, 2d ed., London, 1883.—Hammond (W. A.), Treatise on Diseases of the Nervous System, 7th ed., London, 1881.—Axenfeld (A.), Traité des Nevroses, 2e éd. (augmentée par Huchard), Paris, 1883.—Althaus (J.), On Sclerosis of the Spinal Cord, London, 1885.—Buzzard, Clinical Lectures on Diseases of the Nervous System, London, 1882.

For nervous diseases in childhood, special reference may be made to Rilliet et Barthez, Traité Clinique et Pratique des Maladies des Enfants, 3e éd. (par E. Barthez et A. Sanné), tome i., Paris, 1884.—Gerhardt's Handbuch der Kinderkrankheiten, Bd. V., Tübingen, 1880.

For alcoholic paralysis, see Oettinger, Etude sur les Paralysies Alcooliques (Thèse No. 183), Paris, 1885: also Broadbent, Medico-Chirurgical Transactions, vol. xlix., London, 1884: Dreschfeld, Brain, 1884 and 1886.—For other special forms of nervous disease and some of the newer symptoms, references to the periodical literature are required.

CHAPTER VII.

ELECTRICAL INSTRUMENTS IN DIAGNOSIS.

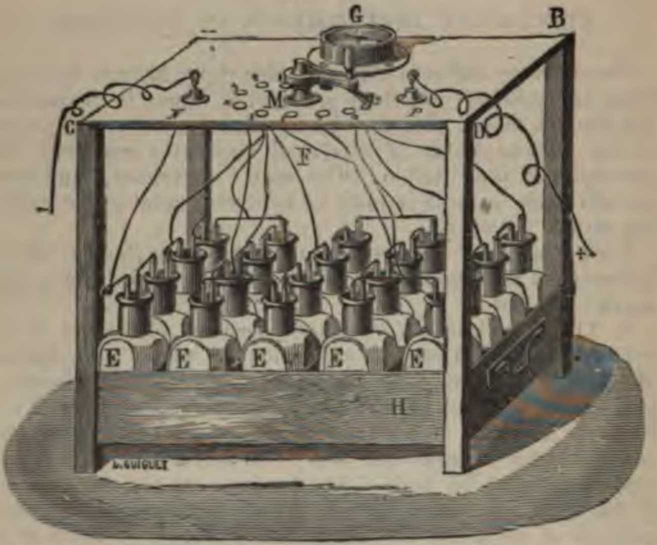
THREE very different forms of electricity have to be recognized in medicine: all three are used at times in treatment: the student should therefore be familiar with the appearance of the various kinds of electrical apparatus and with the principles of their action. The word "electricity," and compounds made up from it, must be kept as general terms including all the varieties.

From the scope of the present work only the use of the instruments in diagnosis will be considered: the subject is thus much curtailed.

I. The Franklinic (or Static) form of electricity is developed by the frictional excitation of plates or cylinders of glass on appropriate cushions. By such instruments a patient can be charged with positive or negative electricity if properly insulated on a stool with glass legs, or some efficient non-conductor; sparks can then be drawn out or passed into various parts of his body. Leyden jars can also be charged in this way. Although furnishing the means used in the oldest methods of electrical treatment, and although it seems to be coming again into more notice of late years for the treatment of disease, this form of electricity has no recognized place in the practice of *diagnosis*. It is, therefore, mentioned here simply to avoid any confusion of ideas which might result from its omission.

II. The galvanic form of electricity is also often spoken of as Voltaic, and from its being excited by the juxtaposition of dissimilar metals associated with chemical action it is also sometimes named contact electricity. The arrangement for producing this form of electricity consists of "a pair" of dissimilar metals and some appropriate exciting material contained in "a cell," the whole of this arrangement being named "an element." These elements are of the most varied character as regards the nature of the metals and as regards the nature of the excitant, as well as its mode of application to the metals by single or double cells; there are also great differences as regards the kind and degree of chemical action which goes on, and also of course as regards the actual size of the elements. The names and composition of some of the common elements will be indicated hereafter. A number of such elements, connected by suitable wires in series, constitutes a "galvanic battery" (or Voltaic pile), and the electricity obtained thereby is spoken of as the galvanic current, or very often as "the primary battery," "the constant current," or "the continuous current,"—these names being designed to distinguish it from the next form of electricity. The strength of such a battery depends on the nature of its elements and on the number of these called into play—10, 20, 40, etc., as the case may be. (See Fig. 38.)

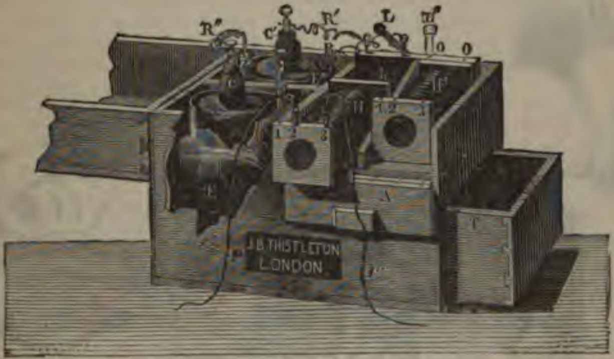
FIG. 38.



Galvanic battery supplying the "continuous current:" 20 elements (E) arranged in series; the terminal conducting wire leading up to the negative pole (N) is shown; there are other wires (F), at stated intervals going to the studs in the dial collector (M) for making connection with the positive pole (P) A galvanometer (G) is included.

III. The faradic form of electricity is the name applied to the induced currents obtained in a coil when this is excited by the influence of a galvanic current or of a magnet more or less suddenly brought into relationship with it or removed from it. This arrangement of galvanic current (or magnet) and coil is called an induction apparatus: as the currents are only produced when the influence of the current or magnet is begun or stopped, some form of interruption is *essential*, and

FIG. 39.



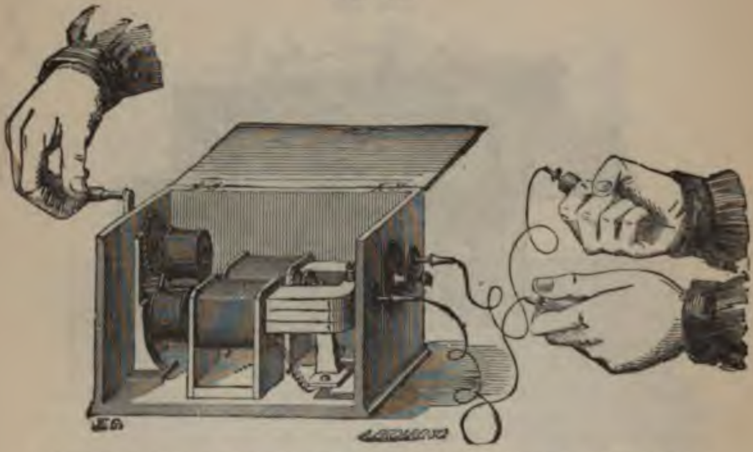
Faradic battery. Electro-magnetic form, supplying the "interrupted current:" there are two elements (E and E′) and two coils: the inner coil h, the outer H. (An extra coil is shown at H′, which can be substituted for the other, H.)

so the term interrupted current is often applied to it in medicine.

Two varieties of instruments for producing this form of electricity are named according to the way it is produced. 1. If the current is induced in the coil by the action of a galvanic current which passing through it *induces* a current in the coil, and at the same time magnetizes a piece of iron inserted into the centre of the coil so as to intensify these induced currents, we speak of this arrangement as an "electro-magnetic battery." (See Fig. 39.) 2. If the excitation is by a magnet which, by mechanical action, is made alternately to act, or cease to act, on the coil we speak of this as a "magneto-electric machine:" the common cheap rotatory machines, with fixed horseshoe magnets and a pair of bobbins or coils, are familiar to all as being sold for medical purposes. (See Fig. 40.) The powerful "dynamo" now used so much for electric lighting is a specimen of the same kind of apparatus.

The essential points in all faradic batteries are the presence of a coil and arrangements for interruptions (even a magnet is not essential, although required in all batteries for medical purposes to intensify the current induced in the coil). According as the current is from the inner or outer coil of such a battery we speak of the "primary induced current" or the "secondary induced current:" or the current from the first or second coil of an induction apparatus.

FIG. 40.



Faradic battery, magneto-electric form. The fixed horseshoe magnets, the two bobbin-like coils, and the arrangement for interruption by rotation are shown.

GALVANIC BATTERIES.

For medical purposes, certain points in the construction of batteries come to be important. For example, we cannot introduce cells with fuming nitric acid into the chambers of the sick, and a certain degree of portability in the battery is often essential in medical applications. Constancy in the strength of the current is also important, but as the applications at any one time are not usually very prolonged, this is of less consequence. More important is it to have batteries which are not very apt to go wrong, or, at least, which can be easily repaired. A general concensus of opinion points to the "Leclanché element" as the most suitable, on the whole, for medical batteries; there are no corrosive fluids used, and but little disagreeable gas evolved; the addition of a little water is usually all that is required for a long time in attending to the cells, and the battery, although long disused, may usually be found quite ready for action without preliminary preparation of any kind.

A battery consists of a group of elements joined together by connecting wires, usually in series, so that the zinc plate of the one element is connected with the carbon (or other equivalent) plate of the next; the terminal plates of the whole series are connected with two conducting wires and handles for the application of the current, the positive and negative poles respectively. The current may be best conceived of as starting from the zinc plate (or the one most easily acted on by the exciting fluid), then passing through the fluid to the carbon, platinum, silver, or copper plate (or the one less easily acted on), and from this point through the wires, when (by means of some conductor) the circuit is made complete by joining the terminal plates, and so back to the zinc plate again to resume its circuit as before; the same circuit goes on through any number of elements which may be arranged in electrical connection.

The current is thus from the zinc to the carbon *within* the cell; but from the carbon to the zinc, through the conducting terminal wires, *outside* of the cell or battery. Some confusion is apt to arise from this distinction; the zinc plate being spoken of as the "positive metal;" the copper, silver, platinum, or carbon being the "negative;" whereas the terminal of the last zinc is the "negative pole," and the terminal of the last copper, carbon, etc., is the "positive." To distinguish which is which in a given battery, we may look to see with which of the metals the conducting wire or the terminal is connected, if the mechanism is exposed to view; sometimes, however, the arrangement is hidden. We may, of course, ascertain which is the positive pole by means of a galvanometer. In the absence of this, the chemical reactions by which hydrogen and metals are liberated at the negative pole, and acids, etc., at the positive, may be readily applied. Iodide of potassium solutions (with or without admixture of starch) are usually at hand; on dipping the two wires from a battery into such a solution in a suitable dish, the iodine can be readily recognized, if the circuit is complete, appearing at the positive pole, with its peculiar color. The term anode is applied to the positive pole, or sometimes the mark + is used; the term kathode or cathode and the sign — are used for the negative pole.

In some forms (Grove, Bunsen, Daniell) the two metals are enclosed in separate cells, usually with different fluids; the inner cell is made of porous earthenware; this allows of a certain interchange of fluids, and prevents the deposition of bells of hydrogen on the platinum, carbon, or copper plates by an oxidizing process due to the fluid there. When there is only one fluid for the two metals, the strength of the current undergoes a rapid diminution during the period of its being in action. A form of Bunsen's element has been devised by Stöhrer with only one exciting fluid, oxidation being obtained by the introduction of chromic acid into the centre of the carbon cylinder.

The "collector," by which we can call into play a smaller or larger number of the elements comprised in the battery, is often in the form of a dial. The diagram (Fig. 38, N, F, and M) indicates how a wire is carried up from the last zinc plate of the series to one of the terminals for the conducting wire representing the negative pole; while a series of connecting wires are led up, at stated intervals, to the studs marked with the numbers; this stud can be brought into electrical contact at the will of the operator, by means of a rotating handle, with the terminal for the positive pole; many other devices are resorted to for the same purpose.

Electrical Units.—The power of a cell is estimated by the amount of work it can do; this can be ascertained in various ways (say by the decomposition of water), and for the purposes of comparison units are established The "electro-motive force" of a Daniell's cell newly charged (with sulphuric acid 1 to 11) may be regarded as very near the British Association standard or unit of electro-motive force; this unit is called a "volt." Some elements have an electro-motive force more than such a Daniell, and others less; this depends on the relationship to each other of the special metals used, and on the strength of the exciting fluid even in cells of the same construction, but the mere *size* of the elements does not affect the amount of electro-motive force or "potential" indicated in volts. The accompanying table may be found useful as a guide in judging of the relative power of batteries with different elements.

Resistance.—The strength of current obtainable from a battery, however, depends not only on the number of "volts" thus at our disposal, but on the resistance they have to encounter. This is of two kinds—the resistance within the battery, and the resistance outside of the battery. The resistance outside may again be divided, in connection with medical uses, into the resistance presented by the conducting wires and handles, which is usually so slight as to be ignored, and the resistance of the human body (or the part of the body) placed in the circuit; this, although variable, is always very great (estimated at 1200 or 1500 ohms, or more by some authorities, even after careful moïstening of the skin). The resistance within the battery can be measured by electricians by special methods which need not be explained here. All forms of resistance are expressed in units of resistance termed *Ohms.* This is represented by a column of mercury of definite dimensions, or, in practice, by a coil of wire of definite length and thickness.

Ohm's Law.—The strength of the current is represented by the number of "volts" or the electro-motive force, divided by the total amount of resistance or "ohms." Or, if we use symbols, $C=$ Current; $E=$ Electro-motive force; $R=$ Resistance; we have, according to Ohm's law, "the current is equal to the electro-motive force divided by the resistance,"

$$C=\frac{E}{R}$$

Unit of Quantity.—The unity of quantity, or the current produced by a "volt" through an "ohm," is called an ampère (formerly a Weber).

If the question of time be introduced along with the quantity, one ampère in a second is called a *coulomb.*

Some confusion still exists from changes in the nomenclature as regards the "weber," "ampère," and "coulomb."

ACCESSORY APPARATUS.

Galvanometer.—The strength of the current may be measured with considerable accuracy by means of galvanometers specially graduated from standards for this purpose. (The ordinary "tangent galvanometer," often supplied with batteries, is useful as determining the

STRUCTURE AND STRENGTH OF VARIOUS GALVANIC ELEMENTS.

NAME.	POSITIVE CELL.		NEGATIVE CELL.		Electromotive force.
	Metal.	Liquid.	Metal.	Liquid.	
Daniell ("unit"),	Zinc.	Sulphuric acid and water (1 to 11).	Copper.	Saturated solution of sulphate of copper.	1.079
Smee (single cell),	"	Sulphuric acid and water (1 to 11).	Platinized silver.	Sulphuric acid and water (1 to 11).	0.508
Chloride of siver (single cell),	"	Solution of zinc chloride (15 per cent.).	Silver.	Solution of zinc chloride (15 per cent.).	1.195
Marié Davy or sulphate of mercury,	"	Sulphuric acid and water (1 to 11).	Carbon.	Mercuric sulphate, mixed with water to a pasty mass.	1.542
Leclanché,	"	Saturated solution of ammonium chloride.	Carbon with manganese peroxide.	Saturated solution of ammonium chloride.	1.561
Bunsen,	"	Sulphuric acid and water (1 to 11).	Carbon.	Nitric acid, fuming.	1.964
Grove,	"	Sulphuric acid and water (1 to 11).	Platinum.	Nitric acid, fuming.	1.956
Bichromate (single cell),	"	Saturated solution of potassium bichromate, to which ⅛ of sulphuric acid is added.	Carbon.	Saturated solution of potassium bichromate, to which ⅛ of sulphuric acid is added.	2.028

passage of a current—showing, therefore, the activity of the battery, the soundness of the connections, and the direction of the current, but in no sense indicating its strength.) In a "dead beat" galvanometer the needle comes rapidly to a stationary point and so is to be preferred in practice.

The division into the 1000th part of the unit is the "milliampère" of de Watteville, and regarded by him as most convenient for medical purposes; 5, 10, 20 milliampères are estimated as equivalent to 10, 30, or 80 Daniell's elements, if the conditions under which they are used are similar, the resistance to be overcome being in the circuit.

Rheostat.—Resistance is measured by "ohms." An instrument for introducing resistance into the circuit is called a "rheostat." The resistance may be graduated roughly by sliding up and down a metal rod, through varying quantities of water or salt water contained within a suitable tube, the bottom of the tube and the sliding rod being both in electrical connection with the terminals of the battery (water rheostat); more accuracy is obtained by using coils of wire of definite length, etc., with known powers of resistance; more recently plumbago has been utilized for this purpose. As the current strength depends on the "electro-motive force divided by the resistance," it is clear that the strength may be varied (1) by increasing or diminishing the number of "volts" (or practically by varying the number of elements brought into play); or (2) by diminishing or increasing the number of "ohms" of resistance by means of a rheostat interposed in the circuit. We may in this way use the full strength of a large battery (say of 80 or 100 elements), and vary the strength in the application by using more or less resistance, the resulting current strength or dose being measured by a suitable galvanometer.

The resistance of the parts of the human body to which the applications are made is so enormous, as compared with the resistance within the batteries we use or in the conducting wires and handles, that it assumes great importance in relation to the strength of current required in medical work. The main part of the resistance is in the skin itself; this is very greatly lessened by complete moistening with simple water, and especially lukewarm salt water; but even when this moistening is carefully done, the individual resistance in the body of one patient may be found to vary much from that of another.

The Conducting Wires or Rheophores.—The amount of resistance presented by the conducting wires varies according to their length, thickness, and composition. As it is desirable to eliminate sources of confusion and make comparisons easier, Erb's standard patterns are to be recommended.

The handles or electrodes require to be of various sizes for applications in different situations. We sometimes require fine-pointed handles, and at other times large flat electrodes for application to the sternum or back. Erb's standards are termed "fine" = ½ cent. in diameter; "small" = 1½ to 2 cent.; "medium" = 4 to 5 cent.; "large" = 5 or 6 × 10 or 12 cent. It is a matter of great importance that some of our handles should be furnished with an interrupter for making or breaking the circuit without any further trouble on our part than pressing a spring; the reactions obtained only on opening or closing the galvanic current can thus be critically watched. It is necessary to have the electrodes covered with some material capable of absorbing water, as this is required to favor the conduction through the skin.

A commutator for stopping the current, and for suddenly reversing it, should also be part of the apparatus in a battery for medical diagnosis. In this way the poles can be changed without shifting the electrodes.

Faradic Batteries.

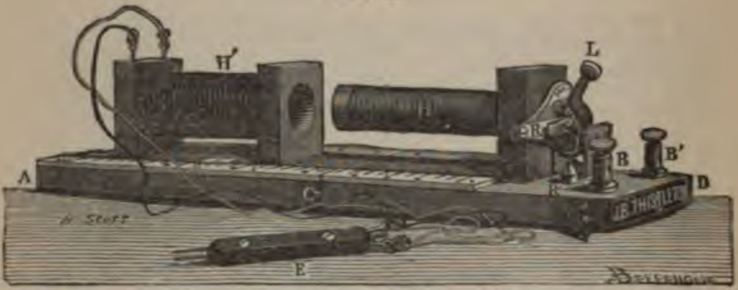
Of the two forms already mentioned, the one with a galvanic element and the other with a fixed magnet, it may be said that the former is much the more serviceable instrument, both for diagnosis and treatment; it simply requires to be started by the operator, and it permits of much more precise regulation of the strength. The second form, unless driven by clockwork, requires some one to turn the handle, so as to allow the operator to have his two hands free; it is less under his control, and the current is very apt to be variable and at times disagreeably painful, from sudden accessions of strength; on the other hand, such an instrument is less liable to be out of order if left unused for long periods.

The current induced in the inner coil of an electro-magnetic apparatus at the making or closing of the galvanic circuit is in the opposite direction to that which comes from the galvanic element itself; this current induced in the inner coil is called the "extra-current" by physicists; its strength on the making of the galvanic current is thus diminished, so far, by the strength of the current from the element itself which is in the opposite direction; on the breaking of the circuit there is no such deduction from the strength of the current thus induced. Although in medical batteries it is called the *primary* current, it must always be borne in mind that it is really a current induced in the coil. The presence of induced currents in the inner coil gives rise, by induction, to currents in the second or outer coil—alternately in opposite directions—on their instantaneous occurrence and cessation; the current from the second or outer coil is called the *secondary* current.

The terminals from such induction coils transmit, therefore, currents in alternately opposite directions in rapid succession, and so we might suppose that the original difference in the current from the positive and negative poles of the element would be lost, and that no distinction in the poles of an induction apparatus could exist. It seems, however, that there is a difference; this can be well shown by reversing the poles of a powerful battery in connection with Geissler's vacuum tubes when the change of color at the poles becomes apparent. The difference can even sometimes be felt in the physiological action of the two poles on the muscles, by grasping in each hand the electrodes of an induction apparatus. It is well, therefore, to preserve the distinctive names of the poles, even in such batteries. Special arrangements have been devised in medical batteries for obtaining the induced current always in one direction; in such batteries, of course, the positive and negative poles are quite distinguishable. (The uni-direction battery of Dr. Dixon Mann, made by Mottershead & Co., Manchester.)

The proper regulation of the strength of current in an induction apparatus is a matter of the utmost consequence both in diagnosis and treatment. The arrangement by sliding the coil along is one of the best methods; in proportion as the outer coil is brought near the magnet (in the centre of the inner coil) the currents in the outer coil are intensified. (See Fig. 41.) Pushing in or drawing out the magnet or bar of iron within the inner coil increases or weakens the current in both coils. Another method sometimes employed is by the application of a copper cylinder surrounding the inner coil, the strength being lessened as this cylinder is drawn toward the magnet within the inner coil. These sliding arrangements are usually graduated so as to afford a rough gauge of the strength of the current employed at a given time. The strength, however, depends also on the exact condition in which the element or elements happen to be at the moment of using the battery.

FIG. 41.



Induction coils, with sledge arrangement, for regulating the strength of current, and a graduated scale: Lever (L) for giving single shocks. Such coils may be driven by a bichromate or a Leclanché element.

The rapidity of the interruptions is likewise important, and they also affect, so far, the strength of the application; they are controlled by screws and springs. For diagnostic purposes arrangements for obtaining single shocks are often of value: this can be done roughly by interposing the finger against the movements of the hammer, but special devices exist in some instruments for this purpose. (See Fig. 41, L.)

Of course, a rheostat may be used as in galvanic batteries for interposing graduated resistance and so regulating the strength of the current as applied. As yet, no accurate estimate of the exact strength of induction currents is available in medical batteries. Scientifically "the capacity defined by the condition that a coulomb charges it to the potential of a volt is called a *farad*."

The strength of an induction apparatus depends on the number and strength of the elements by which it is excited: on the length and fineness of the wire in the coils and on the size and construction of the bar of soft iron or wires magnetized within the inner coil. For diagnostic purposes a powerful instrument is desirable in case such may be required.

Object of Electrical Tests.

We aim at ascertaining the condition of the nerves and muscles in their relationship to electrical stimuli. It is the peripheral nervous apparatus to which the tests are applied and concerning which definite statements can be made; but we are enabled by inferences from these results, and from our pathological knowledge, to judge at times of the condition of the central portions of the nervous system also.

Sensory Nerves.—The nervous system may be explored as to its sensory and motor integrity in transmitting electrical stimuli. The *sensory* impression conveyed from the application of the faradic current corresponds very well with what is termed "common sensation," especially with painful impressions, and the peculiar tingling produced by this excitation may be perceived as affecting not merely the terminal nerves if these are locally stimulated, but the terminal nerves *distributed* from the nerve thus excited. The method of testing will be referred to presently. With the galvanic current, we have, in addition to a true electrical stimulation of the sensory fibres affected by the poles, an irritation from chemical action in the skin going on under the electrodes.

Motor Nerves.—The great nerve trunks and plexuses may be explored as to their power of transmitting *motor* impulses on electrical stimulation, and we may be able thus to see the muscles animated by the branches from such nerve trunks contracting actively, or we may see certain muscles, supplied by certain branches, remaining inactive, in the event, for example, of an injury involving such branches.

Motor Points.—The muscles are found to be readily stimulated by the excitation, with either current, at the point of entrance of the nerve. These are the "motor points" studied by Ziemssen and so important in the practical application of electricity. A normal response thus obtained, shows the integrity of such terminal branches entering the muscle so far at least as the transmission of electrical stimuli is concerned.

Muscles.—The muscular system, however, may be acted on directly by *galvanic* stimuli—individual fibres being excited by the application, even apart, apparently, from any nervous influence. But the preservation of the nutrition and functional activity of the muscle depends very much on the preservation of nervous connections, and so the presence or absence of muscular action, even in a case of injury to the nerve, enables us to judge, so far, of the profoundness of the disturbance thus brought about. Reactions can be obtained in paralyzed muscles on the application of powerful *galvanic* currents so long as the muscle is not hopelessly atrophied.

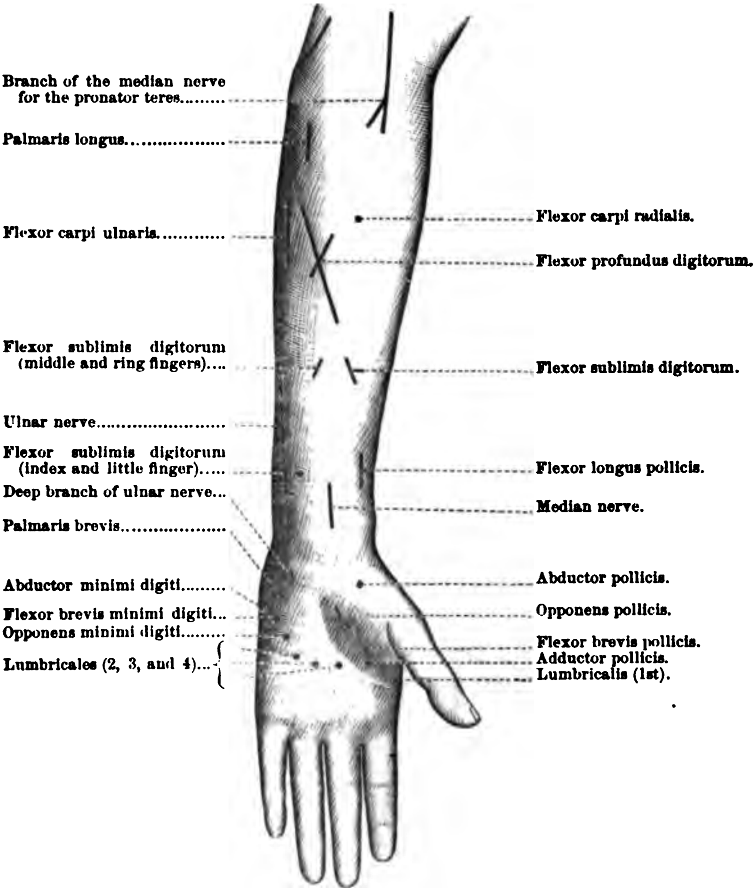
Central Nervous System.—The central nervous system is less available for electric exploration, but certain lesions at the anterior cornua, where the motor roots emerge, come practically to resemble lesions of the motor roots, or the motor fibres of the nerves themselves. On the other hand, lesions in the brain, although producing profound paralysis, leave the nerves quite capable of transmitting electrical stimuli for a long time. Hence the presence and absence of perturbations in the electrical reactions may, at times, be used for inferring the existence or non-existence of a central lesion.

METHOD OF TESTING.

Polar Method.—In applying tests for diagnostic purposes, we try the two poles separately, and, as a rule, we begin with the negative pole or kathode: this applies even to the use of faradic batteries; with them we use the secondary current. By means of a commutator, the current, of course, can be reversed without disturbing the position of the electrodes. The other pole is applied by preference in the form of a flat electrode of large size, duly moistened, and held firmly by the hand of the patient, or by some other contrivance, over a mesial part of the body, such as the sternum, the nape of the neck, or abdomen. The first two are generally preferred: over the sternum the patient may hold the plate pretty equably himself: or by a little padding between it and his clothes it may be properly adjusted and retained: or at the neck a knitted worsted band affords the desirable elasticity, or other contrivances may be resorted to. These situations are selected as being indifferent or remote, and as being equal for both sides of the body in comparative tests.

Nerves.—For testing the *nerves of sensation* we use for the part to be tested an electrode in the form of a wire brush. Erb has devised an electrode having a similar effect, from a multitude of conducting points, without the mechanical irritation of the wire fibres in the brush. This form of application requires, of course, no moistening of the skin. The faradic current is usually employed for such purposes, and we measure by the sliding scales already mentioned the strength required to cause a distinct sensation, however slight, and the strength which gives rise to actually painful impressions. When the two sides can be compared in unilateral disease, we have in this method a pretty reliable basis for ascertaining the degree of impairment. No absolute standard can, however, be laid

FIG. 42.

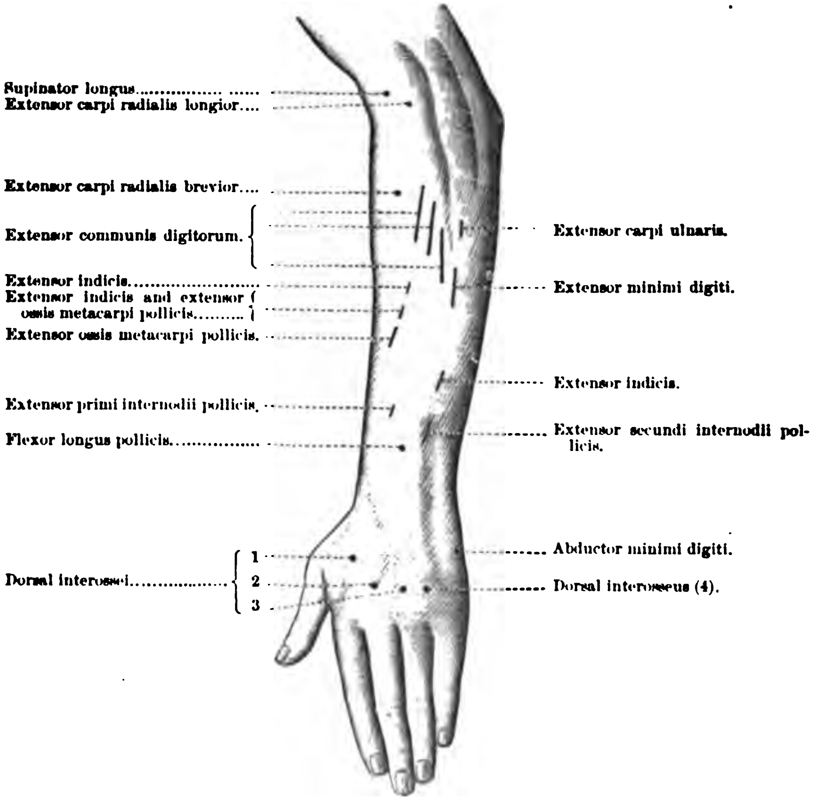

Branch of the median nerve for the pronator teres
Palmaris longus
Flexor carpi ulnaris
Flexor sublimis digitorum (middle and ring fingers)
Ulnar nerve
Flexor sublimis digitorum (index and little finger)
Deep branch of ulnar nerve
Palmaris brevis
Abductor minimi digiti
Flexor brevis minimi digiti
Opponens minimi digiti
Lumbricales (2, 3, and 4)
Flexor carpi radialis.
Flexor profundus digitorum.
Flexor sublimis digitorum.
Flexor longus pollicis.
Median nerve.
Abductor pollicis.
Opponens pollicis.
Flexor brevis pollicis.
Adductor pollicis.
Lumbricalis (1st).

Ziemssen's motor points.

down, and the strength perceived as painful no doubt varies much in individual cases even in health.

In applying such tests, with strong currents at least, muscular contractions may be produced, and the patient may have

FIG. 43.

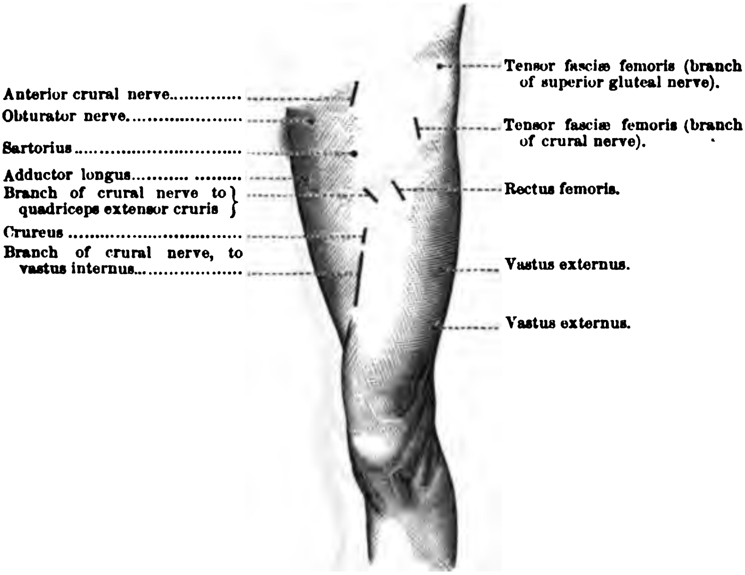

Supinator longus
Extensor carpi radialis longior
Extensor carpi radialis brevior
Extensor communis digitorum.
Extensor indicis
Extensor indicis and extensor ossis metacarpi pollicis
Extensor ossis metacarpi pollicis.
Extensor primi internodii pollicis.
Flexor longus pollicis
Dorsal interossei
1
2
3
Extensor carpi ulnaris.
Extensor minimi digiti.
Extensor indicis.
Extensor secundi internodii pollicis.
Abductor minimi digiti.
Dorsal interosseus (4).

Ziemssen's motor points.

the sense of this contraction in the muscles in addition to the sensation in the cutaneous nerves. This is termed *electro-muscular sensibility*; it varies considerably in degree in certain cases.

The motor nerves are tested with both galvanic and faradic currents. The anode is applied, as before, in the form of a large plate over the sternum or at the nape of neck. The kathode is applied in the form of a "small" or "fine" electrode, according to the size of the nerve explored. In this case the electrodes must be thoroughly moistened by frequent dipping: with the galvanic current warm salt water or weak acid is preferred as greatly favoring the conduction: with the faradic battery simple water is sufficient. Not only the electrodes, but the skin also where they are applied, should be well moistened or soaked. Any difference in this respect may give rise to the appearance of a difference in the electrical reactions when really there is none. The region of the nerve trunk where it is most superficial is selected by preference, and exactly symmetrical spots are selected for the comparison of the two sides. When there is one side sound we have here, of course, a standard in the individual himself, but when both

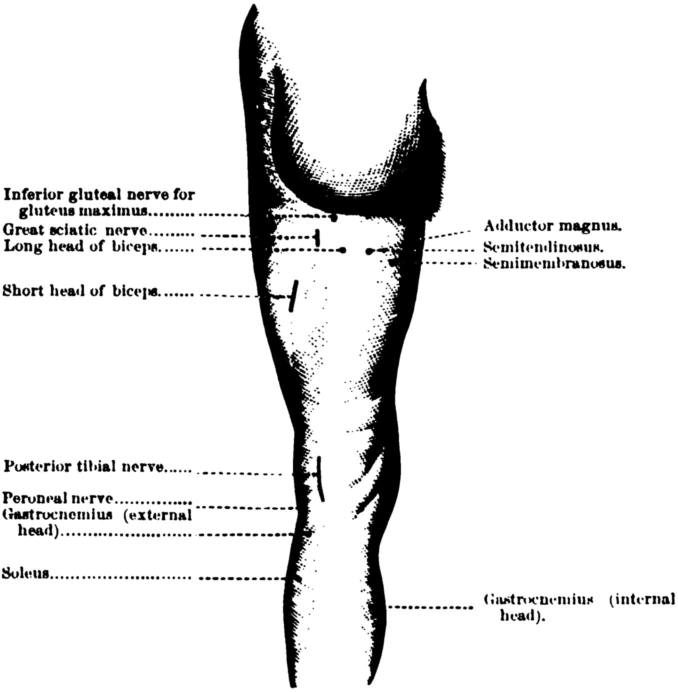
FIG. 44.


Anterior crural nerve
Obturator nerve
Sartorius
Adductor longus
Branch of crural nerve to quadriceps extensor cruris
Crureus
Branch of crural nerve, to vastus internus
Tensor fasciæ femoris (branch of superior gluteal nerve).
Tensor fasciæ femoris (branch of crural nerve).
Rectus femoris.
Vastus externus.
Vastus externus.

Ziemssen's motor points.

sides are implicated in the disease we are driven to general comparisons with other patients, or, better still, with other nerves in the same patient: thus it is found that the peroneal, the ulnar, the temporo facial, and the spinal accessory are usually stimulated to action by a similar strength of current: by comparing the strength required for the stimulation of one of these with that required for another, we can say, even when both sides are diseased, whether there is a notable departure from the normal. It may happen as a rarity, even in health, that there is a marked difference of excitability between the two sides of the body, due to a difference in the resistance of the structures, even after they have been fully and equally soaked with water. The proof of this difference may be ob-

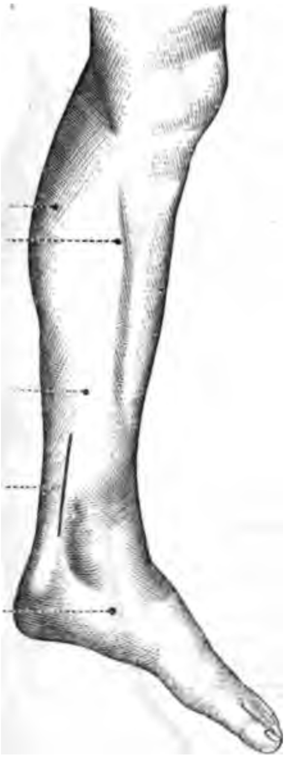
FIG. 45.



Ziemssen's motor points.

tained by means of the galvanometer, and so, if the faradic battery gives such diversities, it may be necessary to test with the galvanic battery and a galvanometer in the circuit before definitely concluding that there is really such a difference.

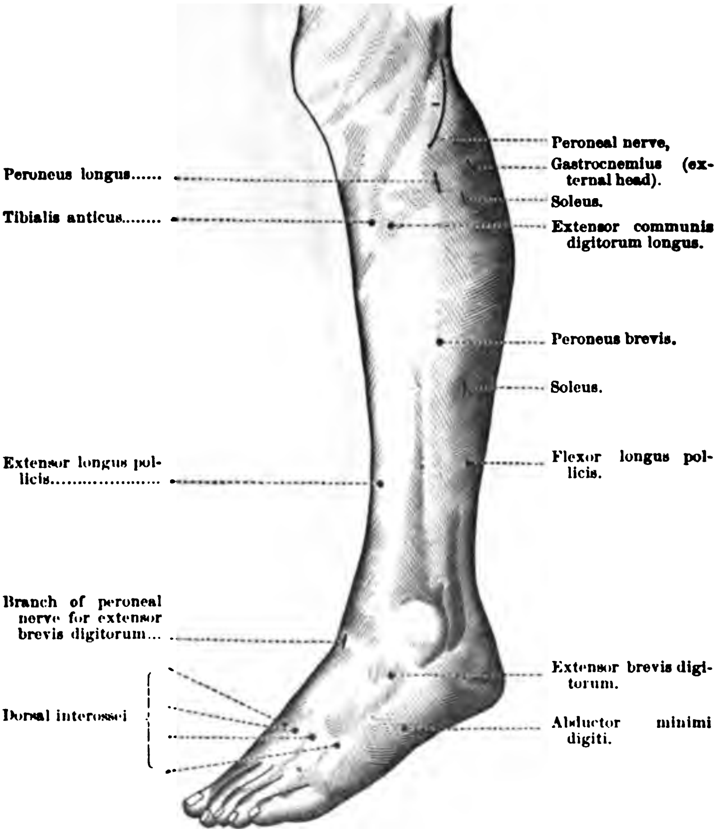
FIG. 46.


Gastrocnemius (internal head)
Soleus
Flexor communis digitorum longus
Posterior tibial nerve
Abductor pollicis

Ziemssen's motor points.

The difference of the reactions in this part of the investigation is one simply of degree; it is estimated by the readiness of response to the currents of various strengths, whether galvanic or faradic. We must watch the contraction of the muscles animated by the nerve in question. Sometimes the observer is apt to be misled by the action of other muscles, animated by quite different nerves, from the indirect stimulation carried to them from a diffusion of the current. In watching the muscular contraction we must have a good direct light falling equally on both sides: we can usually secure this best in the sitting posture. We note the minimum strength of each current, faradic and galvanic, which excites contrac-

FIG. 47.



Ziemssen's motor points.

tion: or we may find an absence of response with the highest strengths of the faradic current, or it may be of both currents. Occasionally in disease the nerves show an increased excitability, but much more commonly there is a diminution or abolition.

In using the faradic current the electrode may be applied for a few seconds, or lifted and reapplied as may seem necessary to assure ourselves of the muscular action; or single shocks may be passed by using the arrangement for this purpose possessed by some batteries (see Fig. 41), or the finger may be used to regulate the action of the vibrating hammer, or interrupting handles or commutators may be used for cutting off and joining the circuit. With the faradic current during the continuance of its passage, the muscle contracts, and, if prolonged, it becomes tetanized.

With the galvanic current the reaction of the muscles is obtained (with ordinary strengths of battery at least) only at the moment the current begins to pass and the moment it ceases—*i. e.*, at the "closure" or "making" of the circuit and at the "opening" or "breaking" of it. This can be readily felt on taking one electrode in one hand and dipping the other into a basin with salt water containing the other electrode; at the moment of putting the hand in there is a shock and muscular contraction, and also at the moment of withdrawing it; during a steady immersion of the hand there may be a tingling sensation but no shock or muscular twitching. This is a point of great importance both in diagnosis and treatment.

The facility with which the shock occurs depends on various circumstances: the strength of the current; which pole is applied; the suddenness with which the circuit is made or broken; and this sudden change is, of course, intensified by the previous passage of a current for a little time in the opposite direction, so that sudden reversings of the current by a commutator afford powerful stimuli. The importance of sudden closures and openings of the circuit calls for the use of interrupting handles, so that the electrode duly moistened may be firmly pressed over the spot, and then the circuit closed or opened as desired. The firmness of pressure with which the electrode is applied to the skin influences the facility of the conduction of the current very much, and so it follows that the gradual application of pressure, or the sliding up of the electrode cautiously from thick cuticle to the thinner skin over the part tested lessens the suddenness with which the change in the nerve is produced by the electrical stimulation, and so lessens the readiness of the muscular response. In applying or removing a soft sponge we have, of course, varying degrees of this suddenness, and this introduces confusion in the comparison of our results; with an electrode held on firmly, and with the circuit closed or opened suddenly by metal connections, we are afforded means for a fair comparison.

"*Localized electrization*" *of the muscles* is effected in two ways. In searching with an electrode over a limb, we find certain "points of election" where the application at once excites the contraction of a given muscle, or of a definite portion of it in the event of its being a large one. These are the "motor points" of Ziemssen, and have been shown to be the entrance points of the nerves to the muscle. They can be learned by a little practice on a limb, but considerable guidance is afforded by the diagrams given by Ziemssen, some of which are here reproduced. We avail ourselves of these points in stimulating the muscles by the pole of either the faradic or the galvanic battery. As before, we test with the faradic current before the galvanic, and, as before, we use the kathode or negative pole first. We note the minimum strength with which the muscles can be excited, and, of course, we notice which muscles or which group of muscles respond to our stimulus and which do not.

With the galvanic current we proceed to ascertain which pole ("kathode" or "anode") over a "motor point" gives a muscular contraction with the least strength of current, and whether this response occurs more readily with the "closing" or the "opening" of the circuit.

In health the order is:

(1) The minimum strength of current gives with kathode, on closing the circuit, a contraction.

(2) Applying more strength, we next get with anode, on opening the circuit, a contraction.

(3) With about the same strength, with anode, on closing the circuit, a contraction.

(4) Lastly, on using a greater strength, with kathode, on opening the circuit, a contraction.

By taking the initial letters of the important words of the above, we have symbols which stand thus, as the order of facility with which contractions are produced in health:

(1) *K. C. C.* = Kathodic closure contraction.
(2) *A. O. C.* = Anodic opening contraction.
(3) *A. C. C.* = Anodic closure contraction.
(4) *K. O. C.* = Kathodic opening contraction.

By using very strong currents in healthy subjects we may with (1) kathodic closure produce tetanus of the muscle; (2) with kathodic opening a slight contraction; (3) with anodic closing, and (4) with anodic opening a stronger contraction. In symbols this is expressed thus: (1) *K. C. Te.*; (2) *K. O. C.*; (3) *A. C. C.'*; (4) *A. O. C.'*

Sometimes we have phenomena produced both of a sensory and motor character with *duration* of the current; this is expressed by the symbol *D.* Thus, *K. D. Te.* would indicate the occurrence of tetanus in the muscle during the passage of the current at the kathode.[1]

Qualitative Changes in Reactions.—We may have in diseased conditions alterations in the electrical reactions, not merely of a *quantitative* character—*i. e.*, either excessive or diminished for a given strength of current, but we may have also *qualitative* alterations. The qualitative changes may show themselves by presenting an *altered series* of reactions in respect of the two poles and their occurrence at the opening or closing of the circuit; thus we may find the anodic closure contraction as readily obtained as the kathodic closure contraction instead of requiring more battery power; it may even be produced with a less strength of current than the other. But further, we may have *alterations in the manner of the contraction;* the muscle may respond to the galvanic stimulant, and may indeed act with a very low power of the battery current, but instead of the normal sudden twitch the contraction may be slow and long drawn, resembling somewhat the vermicular contraction of the organic muscles.

Reaction of Degeneration (R.D.) is an interesting and important phenomenon. "It is characterized in the main by diminution and loss of the faradic and galvanic irritability of the nerves, and the faradic irritability of the muscles, while the galvanic irritability of the muscles persists, is sometimes considerably increased, and is always changed qualitatively in a definite manner." (Erb.)

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[1] The symbols used for electrical reactions were originally introduced in Germany, and, unfortunately, there is some confusion when the initials of the English equivalents are substituted for the initials of the German words. Even in English writings the forms kathode and cathode are both used, and so we may have *K.* or *C.*, or *Ka.* or *Ca.* By using *K.* for kathode, we lessen the confusion from a repetition of *C.* for "closure" and for "contraction" *A.* or *An.* = anode; *K.* or *C.* or *Ka.* or *Ca.* = kathode or cathode; *C.* = closure of the circuit (or making it); *O.* = Opening of the circuit (or breaking it); *C.* = contraction of a muscle; *C.'* and *C''* = very marked and still more accentuated contractions; *T.* or *Te.* = tetanus of a muscle; *S.* = sensation produced on stimulating sensory nerves; *D.* = Duration of the current, as opposed to mere closing and opening of the curcuit. The musical symbols < > (crescendo and diminuendo) indicate increase and diminution: they are used to express the increasing or diminishing loudness in the sounds produced on electrical stimulation of the auditory nerve; they are also used to show the relationship of one reaction of muscle being greater than another (thus *A. C. C* > *K. C. C.* = the anodic closure contraction becoming greater than the kathodic closure contraction). *R. D.* = "Reaction of Degeneration." The German symbols may be also found at times even in English books, and they are repeated here from the last edition of this manual: *A* = anode; *Ka.* = kathode; *S.* = schliessung or closing of the circuit; *O.* = oeffnung or opening of the circuit; *Z.* = zuckung, or contraction, or twitching; *Z.'* = the accent indicates intensification; *z.* = the small letter indicates a feeble contraction; *Te.* = tetanic contraction; *Kl.* = klang or sound.

Almost immediately after the lesion occurs which gives rise to this reaction we have a sudden and usually very great reduction of the muscular response both to the faradic and galvanic current as applied to the *nerves;* often, indeed, within a week or two weeks no response can be obtained.

The same result is found on trying to *faradize* the muscles; very often no response can be obtained at all; sometimes there may be very slight contractions with very strong currents. But with the *galvanic* current applied to the *muscles* (although a slight diminution may be noticed for the first week) we have not only a response to currents of moderate intensity, but a preternaturally ready reponse to very weak currents. Concurrently we have alterations in the polar reactions, in particular the anodic closure contraction being as readily produced, or even more readily, than the kathodic closure contraction; and further, we have the slowness and long-drawn character of the muscular contraction already noticed. We have then (1) loss of faradic and galvanic excitability of the nerves; (2) absence of faradic excitability in the muscles; (3) increased galvanic excitability of the muscles (early induced and lasting for a period of weeks at least); (4) divergence from the normal series of polar reactions with the galvanic current, as regards the relative readiness with which contractions are excited; (5) a slow or long-drawn contraction of the muscle instead of the normal lightning-like twitch.

A partial form of the "reaction of degeneration" has also been described by Erb; the phenomena are less marked and somewhat confusing; in particular there may be a preservation of the faradic excitability, combined with the peculiar changes of polar reaction to the galvanic current already described, and with the latter a slowness in the muscular contraction perhaps only recognizable by a practised eye. The reaction of degeneration may continue to be present after the muscles concerned have recovered voluntary action, and occasionally a reaction of degeneration may be detected (in lead paralysis) before marked loss of power has appeared. The explanation of the "reaction of degeneration" has not yet been fully made out, but the preservation of galvanic contractility with the loss of faradic contractility seems to depend on the extremely short duration of induction currents. From their extremely short duration, the faradic currents, while potent for the stimulation of healthy nerves, seem unable to act directly on muscle; the galvanic current can, however, stimulate muscles directly; even with this form, however, if the currents be interrupted with great rapidity (say 50 in a second), we again find an absence of muscular contraction under the conditions described as furnishing the reaction of degeneration. Why the excitability of the muscle should be absolutely increased in the early stage of this reaction is not so clear; probably the changes going on in the muscle itself bring about this alteration.

Significance of Electrical Reactions.

The significance of electrical reactions as regards the sensory nerves does not require special notice (see p. 280), and the subject of anæsthesia has been already discussed elsewhere (pp. 195–201). Cases with actually increased excitability to galvanic and faradic stimulation of nerve and muscle are few in number, and probably have not always been actually present even when reported. A few cases, however, with this reaction seem to occur at times in the early stages of cerebral paralysis and possibly in the incipient stages of some inflammatory affections of the spinal cord also. This phase is usually of very short duration. In tetany the increased excitability seems to be well authenticated, and it has been alleged with less weight of evidence in chorea. In all these cases there may be presumed to exist a transient stage of preternatural excitability of the nervous centres.

The chief interest in this inquiry arises from the electrical reactions affording indications of the state of *nutrition* of the motor nerves and muscles. The results thus obtained have, therefore, a certain relationship with the examination of the muscles by the finger and eye. (See p. 211.) The electrical reactions and the nutrition of the muscles are both dependent on their nervous connection with the spinal cord through the efferent nerves; hence we have here a certain relationship also with the results obtained on testing the nervous loop concerned in reflex actions. (See p. 216.) But the power of conducting electrical stimuli and of transmitting voluntary impulses from the nervous centres are not synonymous. In a nerve which has been cut both functions are lost; but in a nerve regenerated there *may* be a restoration of voluntary power and yet no transmission of electrical excitation. The student must also remember that there may be the most perfect response to electrical stimuli for a long time in cases presenting hopeless forms of paralysis from destructive lesions in the brain or spinal cord. The following theoretical considerations may help the student to follow the subject as at present understood. So long as the nervous connections of the muscles with the anterior horns of the gray matter of the cord remain perfect, the electrical reactions are but little affected; hence they may be preserved for a very long period, for example, in cases of paralysis from cerebral lesions, till disuse and the resulting atrophy in nerve and muscle have brought about secondary changes. In cases of hemiplegia, therefore, and in many serious cerebral lesions we have the reactions but little affected.

In hysterical paralysis the electrical reactions are normal, and of course the same is the case in patients who simulate paralytic affections. But even in gross destructive lesions of the gray matter of the spinal cord, the motor nerves above and below the affected area may still preserve their connections with the anterior horns unimpaired, and so the muscles animated by these nerves may, as in cerebral lesions, continue to react normally till secondary changes, from disuse or from spread of the disease in the cord, have been set up. (The nerves, however, in direct connection with the destroyed area in a spinal lesion will, of course, have their electrical reactions implicated.) Again, extensive disease of the white columns of the cord may exist without much disturbance of the electrical reactions, inasmuch as these lesions often exist without much tendency to implication of the anterior horns. Hence, even in bad forms of locomotor ataxy and in spastic paralysis we may have a good response to electrical stimuli. We must remember, however, that some spinal affections, beginning elsewhere, may extend their influence to the gray matter, and so we may find changes in the electrical reactions developed in time.

We can equally understand, in view of the relationship of the nerves and muscles to the anterior cornua already submitted, why in sections, lacerations, or other serious injuries of the nerve trunks the electrical reactions are affected. In such injuries we have a rapid abolition of farado- and galvano-contractility in the nerves, a complete loss of farado-contractility in the muscles, and the rapid development of the "reaction of degeneration," already described. (See p. 289.) But the injuries may be less severe, although sufficient to cause paralysis, and as these occur in all degrees, we may have various gradations, from complete loss of electrical reactions to almost complete preservation of them. Thus in paralysis of the arm from pressure during a heavy sleep, or from the use of crutches, the muscles may respond perfectly; in such cases the actual injury to the structure of the nerve is no doubt usually trifling; even then abolition of conductivity of the nerve higher up, on stimulating the brachial plexus, has sometimes been made out.

Closely allied to traumatic paralysis is the paralysis of the facial nerve from destructive ear disease involving the bones; and we have here similar electrical reactions. But we may have a form of facial paralysis from a less severe injury, comparable to that produced by pressure, of which mention has been made in the case of the arm; but the serious character of the pressure in the case of the facial nerve results from the constricting influence of inflammatory products squeezing the nerve against its bony canal, as in the rheumatic and syphilitic affections of the facial nerve. As this injurious pressure may have all degrees of intensity, we may have in slight cases almost no alteration of the reactions, or in bad cases the "reaction of degeneration," and other resemblances to the phenomena presented by a divided nerve; intermediate between these extremes we may have various degrees of diminished faradic excitability. It is clear, therefore, that under certain circumstances the electrical reactions aid us in prognosis, the slighter lesions as indicated by this test being more quickly recovered from. In a few cases of facial paralysis also the electrical reactions aid the diagnosis, in distinguishing a peripheral from a central lesion of this nerve; the bad response to electrical stimuli may afford grounds for a relatively good prognosis; in cerebral forms of paralysis of this nerve the faradic excitability is as usual preserved.

Morbid processes of various kinds and the destructive inroads of malignant tumors may of course destroy the trunk of a nerve in any part of its course, and so give rise to electrical reactions resembling those found in traumatic paralysis. But diseased processes in the nervous system itself may produce lesions practically equivalent to a traumatic injury, although higher up than the mere nerve trunk. In infantile paralysis we have a lesion in the anterior cornua of the spinal cord, which by its destructive influence on the large cells and tissues there cuts off the motor roots of the spinal nerves from the connection which is so important for the nutrition of the muscles: hence the rapid wasting in this disease; hence also the rapid change in electrical reaction. In this disease, as in bad cases of facial paralysis, we get results similar to those found in divided nerves, and the "reaction of degeneration" is very common, at least in bad cases, and is rapidly developed. But the wasting and the electrical changes do not affect the whole limb indiscriminately: special groups of muscles are selected, for reasons which are not clear, but in connection with which Ferrier's investigations on the roots of the spinal nerves have some bearing. (See foot-note, p. 211.)

In grave forms of myelitis affecting the gray matter of the cord we can understand the great diminution of the electrical reactions, and indeed there may be complete absence of contraction with either faradic or galvanic current. We must remember, however, that in equally serious disease of the spinal cord we may have good electrical reactions in connection with nerves not directly springing from the diseased area. (See p. 292.)

In progressive muscular atrophy (although the lesion is probably in the anterior horns) the electrical reactions are less altered: we often have indeed a diminution in the response, but this seems so far explicable by the diminished bulk of the muscle; later in the case, according to some, there may be a partial "reaction of degeneration." Similar remarks apply to bulbar paralysis.

It is not easy to understand the reaction of the nerves and muscles in paralysis from lead poisoning, unless we assume that the poison influences specially the roots of the spinal nerves concerned. It is very common in such cases to have great loss of farado-excitability or abolition of it altogether, with the "reaction of degeneration" well marked. Here also, as in facial paralysis, the different degrees of reaction are very great, and for similar reasons the electrical reactions guide the prognosis, the recovery being much quicker when the loss of faradic excitability is slight. In rare cases alcoholic paralysis simulates lead poisoning in the electrical reactions as well as in affecting the extensors.

In pseudo-hypertrophic muscular paralysis the faradic excitability is preserved till the case is far advanced and the muscles much destroyed, but owing to the wasting being greater than might be supposed, and owing to the resistance from the excess of adventitious tissue, the reactions often appear diminished, both as tested over the nerves and over the muscles, but particularly in the latter case.

The two great advocates of the galvanic and faradic forms of electricity respectively are Remak and Duchenne.—Remak, Galvanotherapie der Nerven und Muskel-krankheiten, Berlin, 1858. — Duchenne, D'électrisation localisée, 3e edition, Paris, 1872: portions of this great work have been translated by Dr. Poore for the New Sydenham Society, London, 1883.

Students not familiar with electrical experiments would do well to read and practise the experiments given in an admirable series of lessons by Dr. De Watteville, Practical Introduction to Medical Electricity, 2d edition, London, 1884 This book can also be recommended for instructions in the diagnostic and therapeutic uses of electricity.—Erb, Handbook of Electro-therapeutics, translated by Dr. Putzel, London, 1883: important works bearing on this subject by Erb are also available for English readers in the translation of Ziemssen's Cyclopedia.—A. Hughes Bennett, Practical Treatise on Electro-diagnosis, London, 1882.—Althaus, Medical Electricity, 3d edition, London, 1873.—Tibbits, How to use a Galvanic Battery, London, 1877: Dr. Tibbits has also translated a portion of Duchenne's work dealing with instruments, and he has published a pamphlet on static electricity, London, 1886.—Beckensteiner, Etudes sur l'électricité, Lyon, may be consulted especially as regards static electricity.—The works of Meyer; Onimus; Rosenthal and Bernhardt; and Beard and Rockwell may also be mentioned.

CHAPTER VIII.

INSANITY.

onsidering the forms of insanity, it is desirable
ning of certain terms, which are of constant use
mental disorders, should be clearly understood.

Iallucinations, and Delusions.—Illusion and hallu-
reference only to disordered perceptions. Both,
together, may exist without insanity. In order
ence of an illusion a *real* impression must be pro-
sensorium; but this impression appears in con-
very different from the actual fact. The impres-
cases comes from without, and is transmitted
r other of the senses (by far the most frequently
of hearing and sight); but it may spring from
ernal organs. On the other hand, an hallucina-
en no impression has been produced on any of
d it is equally independent of visceral sensations.

Delusion, strictly regarded, pertains exclusively to the highest mental functions, and has no direct connection with sensation in any form. A man who asserts he is ten thousand years old, or that he is the Almighty, labors, therefore, under delusion proper. But though the term is occasionally employed in this restricted sense, to distinguish it from those already described, it is also commonly used generically to include them all. It may thus be correctly applied to either illusions or hallucinations, if they are the result of disease, and are not corrected by reason. In a court of law, as a matter of expediency, it is advisable to avoid the latter terms, and to designate all morbid ideas of lunatics as "*insane* delusions;" the word delusion *by itself* being often popularly used to describe a mere unfounded belief.

The chief forms of insanity, according to the best established classification, are mania, melancholia, monomania, dementia, and idiocy; and besides, there are several important varieties which will be briefly described. *Mania* implies considerable general excitement, which is usually accompanied by incoherence of ideas, delusions, and violent conduct; but there are varieties of mania without incoherence or distinct delusions. In *melancholia* there is mental depression with delusion generally limited to one or to a small number of subjects. There is also simple melancholy without delusion. In *monomania* there is no depression, but generally exaltation or perversion of feeling; delusion is restricted to one or (much more commonly) to a small number of subjects, all of the same character; but the intellect, although often wonderfully clear and acute in other directions, is not altogether free outside the morbid circle. In *dementia* the powers of the mind, previously of average vigor, are enfeebled or destroyed. In *idiocy* the original mental development has fallen far short of the normal standard, either through a congenital cause or one occurring in early childhood. Imbecility is this state in a minor degree.

Premonitory mental symptoms almost always precede an attack of any of the acquired forms of insanity. These are to be looked for in disturbance of the emotional powers rather than in an abnormal state of the intellect—the latter condition being subsequent to the former. There is usually a preliminary period of depression, and this is often seen even where the fully pronounced derangement is a state of excitement. The patient has a vague feeling of discomfort, of mental weariness and pain. There is unwonted irritability; trifles that would formerly be unheeded now fret and worry; those most loved and bound by the closest ties of kindred are regarded with suspicion, jealousy, and aversion; a feeling of baseless apprehension, and sometimes a painful anticipation of insanity, are experienced: unusual vacillation of purpose may be a feature; and the sufferer, particularly in the premonitory stage of melancholia, may likewise have a weariness of the world, and a longing for death. Such feelings and dispositions in various combinations form the foundation of morbid sentiment on which delusion, in its varied forms, is based. In some cases of mania, however, there is no preliminary depression and the initiatory stage is one of gradually increasing excitement.

Mania.—In *acute mania* the preliminary stage of depression with iritability, should it exist at all, is not generally of long duration. About the period when it is giving place to excitement there is occasionally a general susceptibility of the nervous system, characterized by exceeding sensitiveness to sharp and loud noises, and to bright light, and also by a disposition to sudden and violent starting of the legs and even the whole frame, especially when about to fall asleep. Some people are, however, subject to similar startings in a minor degree from slight causes, such as derangement of the digestive system, and many epileptics suffer from them in the intervals between the fits.

The mental excitement may show itself very gradually, or it may be quite sudden in its onset. The disorder of the intellect occurs in degrees varying from scarcely noticeable rambling in conversation to complete incoherence. Cases which are characterized by mere exaltation without obvious intellectual disturbance have been named simple mania. In this condition patients generally act very foolishly, quite unlike their former selves, although, at the same time, they are very ready with a plausible excuse for their improprieties of conduct, and it may be very difficult, and at first perhaps even impossible to certify that they are insane. In the majority of such cases, after an interval of weeks or months, the gradual development of incoherence, with or without delusions, shows that the intellect has become distinctly involved; but some undergo no material change, however protracted their duration. The writer has had cases for years under his care, chiefly elderly females, in which a meddlesome disposition that was the source of much mischief both amongst fellow-patients and attendants, a general forwardness and recklessness of conduct, a slight and not very obvious rambling in conversation, and an excitability of temper, were almost the sole evidences of insanity. That this mental condition was, however, attributable to disease was supported by the fact that in the most marked of these cases there had been attacks of ordinary insanity in early life, and that the excitable demonstrative mood was not natural to the person, but had set in after a long incubation of abnormal quietude and reticence. The mental derangement in some patients corresponds very closely with the "moral insanity" of the alienistic physician Prichard, to be afterward noticed.

In ordinary acute mania illusions and hallucinations, particularly of sight, as well as delusions proper, are very common, although, as already stated, mania may exist without any of them. A distinguishing feature of the morbid ideas is their evanescence; they are not fixed, even though the same kind of fancies may recur from time to time. Besides the intellectual disturbance, there are general restlessness and impatience, a hurry, a confusion, and an unusual disposition to action. Some patients are in a happy, joyous mood; others are angry and irritable; not a few alternate between these states. The conduct is often violent and disgusting: shouting, singing, gesticulating, quarrelling and fighting, tearing clothes, smearing the person and bedroom with feces, and other filthy actions. Outrageous conduct is often first manifested during the night. It is to be observed that both delusions and actions are stamped by the character of the prevailing morbid emotion.

From the very commencement of the illness sleep is almost always deficient in amount, and is occasionally absent altogether; or, what is more common, it is obtained for half an hour or an hour, now and again, the patient awakening in no respect improved. Terrifying dreams often disturb these brief snatches of sleep. The appetite, although frequently considerably impaired in the early stage of the disorder, is usually good when it is fully developed, and, indeed, is sometimes abnormally keen. But, notwithstanding the large quantities of food consumed, nutrition is not well maintained, and many patients distinctly fall off in condition. The tongue is moist and clean in many cases, but may be furred and yellow, in which case the breath will probably also be unpleasant. The bowels are generally confined, and the stools are apt to be offensive, but occasionally a tendency to diarrhœa is seen. Thirst is seldom present. The urine is commonly diminished in quantity, increased in specific gravity, of acid reaction, with an excess of phosphates; but occasionally it is neutral or even alkaline, and the amount may be normal. Excitement of the sexual instinct, which is not rare, may show itself in masturbation and indecent exposure of the person. Menstruation is usually altogether or in a great measure suppressed. The menses generally return coincidently with recovery, but their appearance does not always herald the advent of convalescence; and, on the other hand, mental health may be restored while they continue in abeyance. In the majority, the skin is somewhat harsh and dry, but it is quite common to find it soft and moist; its secretions are often disagreeable in odor. An increase of the evening temperature by about a degree F. is common, and should the patient's exertions be violent there may be a similar elevation at any time of the day while the excessive muscular action lasts; but, with these exceptions, it does not ordinarily rise above the average of health. Abnormal heat of head, especially of the vertex, is often noticeable. In a few cases there is excessive salivary secretion. The pulse, as a general rule, is from eighty to ninety in frequency, and of diminished volume; but there are many exceptions, some being a few beats above and others below that range. In the early stage the conjunctivæ will sometimes be found somewhat injected and yellowish, but this is not common when the excitement is fully established; the aspect is then frequently bright and glistening. The expression of the countenance as a whole is altered, and the change is occasionally so great that relatives have a difficulty in recognizing the sufferers. The mental exaltation, the incoherence, and the delusions are reflected in the face: there may be the tense, fierce look of a painful morbid idea, or the relaxed joyous expression of the equally morbid but more happy thought, or simply the absence of that due fixity or natural change of feature which accompanies the thinking process in a state of health.

Acute mania occurs occasionally in a more asthenic form than that just described. The physical symptoms are indicative of greater debility; the pulse is weak and quick, the pupils wide, the face pale, and there is often distinct anæmia. The psychical disturbance is also more uniformly high. In short, this form holds a middle position between the sthenic and the one next to be considered; and there is a gradation of cases connecting all three.

The variety now before us corresponds in some respects with severe delirium, and is hence known as *acute delirious* mania. The incoherence in this state is complete; the patient talks or shouts in fragmentary, disconnected sentences, and the excitement is very high. There are no definite delusions, the mental disorder being apparently too great for formulated thought of any kind, but in some cases indications of transitory hallucinations and illusions are observable in the midst of the ravings. Such patients are generally violent and destructive and of dirty habits, but their acts differ from those of ordinary acute mania in partaking more of blind fury, with less distinct consciousness in the agents. The physical symptoms are proportionately intensified. The pulse is generally very quick and weak, the conjunctivæ are injected, and the pupils are often smaller than the normal, the skin is parched and hot, the tongue is dry, tending to brown, the appetite usually is in abeyance, and there is very often a sickening odor from the breath, a degree of thirst is common, and there is an almost total absence of sleep. There is a high mortality in this condition, but should the tendency to death from exhaustion be overcome, the patients usually make excellent and speedy recoveries from their mental disorder. Cases in which the pulse is not greatly accelerated and the temperature is but little raised are the most hopeful; the opposite conditions are of evil omen.

Mania transitoria is a variety which, as its name implies, passes away quickly—even in a few hours, or at longest in a day or two. The symptoms are those of the most acute form of sthenic mania. The seizure occurs suddenly, and is most frequently met with as a result of mental shock or of intoxicating liquor in persons who are of the "insane temperament" —who, in their ordinary health, are excitable, nervous, odd in their opinions, and peculiar in their general conduct—this condition being usually the fruit of heredity. It is also apt to show itself in individuals who have had sunstroke or whose heads have been injured (possibly many years previously), after a slight excess in alcohol, or from a moral cause, such as sudden and great provocation. When due to alcohol, this is the "mania a potu," properly so called.

Chronic mania may be considered as established when—the symptoms of the acute stage having somewhat subsided, after some months' duration—the delusive ideas are more definitely formed than at first, the incoherence is still considerable, though somewhat less, and the excitement is not so constant, but more paroxysmal in its character. At this period, illusions and hallucinations, especially of hearing, are commonly present; but one or more of the other senses also are frequently involved in the same patient. The bodily condition is now generally good. This is the state of a large proportion of the inmates of asylums. It may last for many years in much the same form; but, what is more common, by slow degrees the mind becomes more and more enfeebled till at length its powers are irretrievably lost in the ruin of complete dementia.

Melancholia stands next in importance to mania as a leading form of insanity. It is often met with as *simple melancholy*, without delusion or distinct intellectual derangement of a positive kind. Yet in most cases neither the intellect nor the will is free; they are distinctly enfeebled. The sufferer cannot duly concentrate his attention on any subject or reason it out to a conclusion with his former ability. The emotional distress is overpowering, and the whole course of thought is swayed and broken by the strength of the morbid feeling. Many are desponding and lethargic, do not interest themselves in the ordinary affairs of life, shun society and seek to be alone, nursing their gloomy thoughts. In others the mental distress is more active, showing itself in restlessness and agitation, wringing of the hands, and in the unhappy, woebegone countenance. Although there is no definite delusion, there are usually forebodings of evil, the future is all dark, no ray of hope illumines their sojourn in this world, or perhaps even the prospect beyond the grave. A disposition to suicide occasionally arises, and this should always be borne in mind, but it is not so common as in the more pronounced forms of melancholia. There is derangement of the general health. Anæmia is usual, with chilliness, particularly of the extremities; the pulse is often slower than normal; in women leucorrhœa is common. The appetite is poor, and there is sluggishness of the bowels, the colon more especially being inactive and frequently loaded. In many cases an insufficient amount of sleep is obtained, but in some it is not deficient. The patient's slumbers are often disturbed by hideous dreams, and are not refreshing. There is not unfrequently a disposition to lie abed till the morning is far advanced, and it may be only by a degree of constraint that the sufferer can be got to rise and dress. Usually the morbid feeling is at its worst in the morning, and as a rule there is some abatement as the day advances. It is worthy of note that a sense of the ludicrous may exist along with this depressed emotional state.

Hypochondriasis passes into melancholia when the more or less imaginary troubles that affect the patient amount to actual delusion, out of which he cannot be reasoned. In illustration of this, a patient complained for a long time of uneasiness, and sometimes of severe pains in the abdomen, for which there was no very obvious cause; then she became miserable, and declared that the devil himself was in her belly. Her first condition could not be pronounced to be insanity; but when the delusion arose, the proof of it was clear. In hypochondriasis the depression of feeling is seldom so great as in melancholia, nor is it so completely beyond the patient's control; and, instead of a disposition to suicide, there is usually fear of death, and apprehension that the unreal, but not the less dreaded, troubles will prove fatal.

Acute melancholia may be suddenly caused by a severe mental shock, but it is much more frequently preceded by a long preliminary stage of depression. When the disorder is fully developed, the unhappy feeling may attain to one of despair. The wretched sufferer may utter loud lamentations, tear his hair, strike his breast, and even make desperate attempts at self-destruction. It is seldom, however, that the condition is so bad as this; but there are all degrees between simple melancholy and the state just described. The attitude and the expression betoken the mental frame. In some the arms hang heavily by the side, the eyes are turned downward toward one point, and are almost statue-like in the fixity of their gaze, and the angles of the mouth are depressed; or, the morbid feeling being more acute, the hands are clenched, the features are tense, and the sufferer moves about in restless agitation. The latter variety is less common than the former. Notwithstanding their misery, melancholics seldom shed tears; their sorrow is too deep for that. In most cases they are decidedly worse in the morning, just after awaking from sleep. Although in general sleep is broken and much disturbed by unhappy dreams, it is by no means so deficient in amount as is the case in acute mania. The pulse is weak and not accelerated; the skin is clammy and cold, and the lips have a purplish tinge; the tongue is apt to be furred, and is sometimes indented at the edges; the bowels are generally constipated, and the breath offensive, and the stools are occasionally deficient in bile. There is usually amenorrhœa in women. Refusal of food is common, and may arise from delusion, from suicidal intent, or from real derangement of the digestive organs. Precordial anxiety is not uncommon; and in some cases of intermittent melancholia the paroxysm begins with this sensation, which seems to the patient to extend upward to the head, and then the gloom and mental pain are experienced. In some cases—fortunately rather rare—the physical symptoms correspond closely with those of delirious mania, and as in it also the mortality is high.

There is a form of melancholia known as *melancholy with stupor*, or *melancholia attonita*. It has two varieties, depending on whether the element of stupor or that of profound melancholy prevails. The symptoms are much alike in both. The patients stand in the one position, or continue the same motion, heedless of what passes around; they require to be fed, and often resist artificial feeding; and they are frequently inattentive to the calls of nature. The circulation is languid, and the skin is cold and bluish. The varieties are best distinguished by the aspect. In the melancholic the features are tense, and the countenance, as a whole, betrays fear or anguish so deep that the mental powers are overwhelmed; whereas, in the other, while a certain amount of depression is evident, stupidity predominates in the expression. A general resistive disposition is a marked feature in many cases, especially of the *melancholic* variety, any interference with the patients, such as removing them from one seat to another, inducing strenuous opposition on their part. Some exceptional cases are characterized by the occurrence of epileptic or epileptoid fits, but generally at long intervals. Convulsive seizures in which consciousness is preserved are more common; such motor phenomena are, however, amongst the rarer accompaniments of this form of disorder. In both varieties it often happens that serious disease in other organs, particularly the lungs, is insidiously progressing though manifesting very indistinct symptoms.

Acute melancholia, though often recovered from in a few weeks or months, may become chronic, or the chronic form may supervene on acute mania, in which case there is usually more or less dementia along with it. Whatever its origin, melancholia, if confirmed, has a tendency to pass into dementia, though that frequently does not occur for many years. The chronic forms are not unfrequently associated with disease in one or other of the abdominal organs, on which they may be partially dependent. The ordinary forms are incident to middle or declining life, though it is not rare to meet with them in young people. Melancholy with stupor, on the other hand, is much more a disease of youth than of age.

Monomania is generally used to signify partial insanity of the intellect. The term is misleading if it be regarded as meaning mental unsoundness on *one* subject, the judgment and the emotional powers in other respects being absolutely free. However limited the delusive idea, the natural tone of the mind is always altered—elevated or depressed, expanded or contracted—and there is also a morbid exaggeration of self-feeling. At the same time cases are not rare where the intellect is wonderfully sound and vigorous outside the sphere of morbid ideas. Thus, two cousins, men about forty years of age, came under notice at the same time, the one of whom fancied that his penis was once, somehow, tampered with by his fellow-workmen, and also that on several occasions, without his consent, he had been acted on by electrical agents; whilst the other declared that he himself was "a little Christ." On all other subjects they were apparently sensible, intelligent men, with whom one might talk for hours withot discovering their morbid fancies, unless one had a clew to them previously; but the unhealthy state of feeling above referred to was quite obvious. The delusions of monomania are of endless variety. They may be roughly grouped according to the prevailing morbid sentiment, which, as has already been said, lies at the root, and precedes formal delusion. One class, in which there is exaltation of feeling, is characterized by morbid ideas respecting power, wealth, talents, personal appearance, etc. In another class, suspicion being the prevailing sentiment, the patient may probably imagine that there is a plot against his life, that spies dog his footsteps, and that his food is drugged. Prompted by such fancies, lunatics in a number of cases have killed their imaginary persecutors. Hallucinations and illusions, especially those of hearing, besides delusions proper, are common. They are very important should they assume the form of "voices" conveying commands to the patient, and particularly should there be any disposition to obey. This, as previously mentioned, is a frequent source of suicide and homicide in the insane.

Monomania, especially when accompanied by hallucinations of hearing, is an intractable form of insanity. Still, occasional recoveries do take place after it has lasted for several years. In most cases, as time passes—it may be not till after many years—additional delusions spring up, and the morbid circle gradually widens till the intellect is entirely involved. Then there is also incoherence, the mental degeneration having passed into incurable dementia. The general bodily health during this slowly progressive mental decay is usually very good.

Dementia is usually the sequel to other forms of mental disorder. Mania occasionally passes into it after a few months, but this is not usual till a much longer time has elapsed. Melancholia and partial intellectual insanity, as a rule, reach dementia at a considerably later period than mania does; often not for many years. But chronic progressive dementia may be primary, and arise independently of any antecedent disorder of the mind. The condition ranges in degree from slight enfeeblement, characterized by dulness of apprehension, weakness of memory, and inability to follow out a subject; or by general silliness of language and conduct; to complete mental disorganization, in which the patients are unable to comprehend the simplest questions, and require all their wants to be attended to like an infant. In most cases, however, even when the intellect is in this degraded state, dements can take their food themselves. Many are grossly indecent in their conduct and are dirty in their habits, and some have an abominable disposition to eat their own feces and drink their urine, though by careful watching and training they can usually be led to give up the practice. When the psychical ruin is less complete, but still in cases where there is great incoherence of thought, patients are quite able to follow manual occupations, such as shoemaking or tailoring, to which they had been trained previous to their insanity. The bodily health in this state is generally good, and there may be marked obesity.

In secondary dementia there may usually be observed traces of the particular form of derangement which prevailed at the departure from mental health. Thus, in the epileptic variety, irritability and a disposition to violence are marked features; in the general paralytic form there are the delusions of grandeur; in that of monomania fragments of the original delusions are often observable; and when it results from mania there are occasional bursts of excitement with incoherence and fragmentary delusions, making it occasionally difficult to tell whether a particular case ought to be regarded as chronic mania or dementia. The vestiges of the primary mental disorder are not, however, traceable in the last stage, except in epileptic and paralytic varieties.

Senile dementia is particularly characterized by failure of memory respecting recent events, while the long past is often remembered with considerable accuracy. There is also more or less incoherence of ideas. Sometimes there are delusions which are seldom persistent, though while they last they may incite to violence. Feebleness of purpose and facility of disposition are ordinary features. Cases are to be met with in which there are occasional attacks of maniacal excitement, lasting for a few days, and followed by depression and exhaustion. A tendency to indecency of conduct has been manifested in a number of instances. In some cases there are restless agitation and sleeplessness, or very insufficient sleep at night. The physical signs of old age accompany this mental condition. From various causes senility may appear long before the usual period of life.

Other forms of Senile Insanity.—It would be a mistake, however, to suppose that the other leading forms of mental disease do not appear in the later periods of life. Thus, one of the most common of these forms is a variety of monomania, that, namely, of suspicion. Groundless jealousy of near relatives, and aversion to them may be the earliest marked symptoms; but there are usually also other indications of mental disturbance such as violent explosions of anger from trifling causes, along with strange and extravagant conduct, quite at variance with the previous disposition of the individual. Ere long, failing memory and other evidences of general intellectual enfeeblement reveal the advancement of the mental decay. Melancholia is not generally characterized by the same fixity of feeling and consciousness in morbid thought as when it presents itself before the development of senile changes of structure. Thus it is not unusual for aged melancholics to be very miserable and even suicidally disposed at one time of the day, generally the morning, and comparatively cheerful at night. Mania, again, though marked by as much incoherency as in many of the forms already described, is lacking in the vigorous demonstrations in word and action which these forms usually present. It is not more than might have been expected, that even abnormal processes of thought should not have that acuteness and intensity which we are accustomed to find in the earlier periods of life, while yet the cerebral, equally with the other tissues, are free from the degenerations incident to advancing years.

It is by no means unusual to have recovery from the senile forms of insanity, save that of dementia, which may be regarded as a hopeless condition. For instance, the writer had under his care a patient, eighty-three years of age, who made an excellent recovery in about two months from a well-marked attack of acute mania.

Organic dementia is the name given to a variety which occasionally follows apoplectic seizures, either without paralysis, or associated with hemiplegia or other obvious organic disease of the brain. In the majority of hemiplegics, both old and young, there is marked emotional weakness, manifested by a tendency to weep immoderately to appearance, though it is seldom that any tears are shed. Occasionally in the same person there is an equal readiness to laugh, but the fit of laughter generally ends in weeping of the form described. The memory is also weak, and the judgment impaired. When the paralysis is on the right side, and is accompanied by aphasia, there is, as a rule, less indication of weakened feeling than when it is on the left side. In very many cases of organic dementia the patients are stupid, silly, and facile; and on the physical side, besides paralysis, they suffer from disease of the heart or kidneys and frequently of both organs. But it is well to bear in mind that the mental derangement—which is often largely maniacal in its symptoms—which sometimes follows an apoplectic seizure, occasionally improves greatly, may indeed entirely pass away on the gradual subsidence, or possibly complete removal, of the lesion within the skull.

Acute or primary dementia is very different in its nature from the varieties which have been described. Indeed, it has so little real kinship with the other forms of dementia that in some recent treatises on mental disease the name has been discarded altogether, and *stupor* used in its place. There is, however, the very serious objection to the latter term that both in the popular and medical mind it has been long associated with a mental condition other than insanity. It has, therefore, been thought better to retain the name with which it has been so long associated and is still very generally known. Acute dementia occurs in the young, more frequently in women than in men, and is prone to affect those who are naturally feeble-minded and excitable, more particularly if there be a hereditary tendency to insanity. It is usually the result of a severe mental shock, such as fright, unexpected bad news, etc.; and its occurrence is often quite sudden, or within a few days after the shock has been sustained. The powers of the mind are in almost complete abeyance, but they are not destroyed. The patients stare vacantly when addressed, evidently not understanding what is said to them. They perhaps make grimaces, or perform actions automatically, but more commonly they remain in the same position, unless moved from it, their arms hanging heavily by their sides, and their aspect blank and stupid. They may become distinctly cataleptic, though this is somewhat exceptional. Their circulation is languid, the extremities and features being bluish, and their general condition is soft and flabby. Nutrition is not well maintained, and they occasionally become considerably emaciated. They are often inattentive to the calls of nature. The prognosis of this form is generally favorable, but the writer has seen several cases, especially when the cause was fright, where the disorder became permanent. He has also observed an attack of acute mania intervene between this state and recovery. Usually, however, it gradually passes away, *pari passu*, with the restoration of the general health.

It will be observed that acute dementia resembles somewhat closely "melancholy with stupor." The two forms are distinguished chiefly by the facial expression; in the latter—at least in the more common variety—it is intent and fixed, indicative of the profound mental concentration; whereas in the former it is vacant and meaningless. In cases, however, where the element of stupor predominates over the melancholy, the diagnosis is sometimes very difficult. It occasionally happens that the disorder begins as melancholia, and gradually lapses into complete stupor. It will be observed, on reading the next section, that there is also a close resemblance, or rather identity, in many of the symptoms with those of "Katatonia." In fact, the relationship of the three conditions—acute dementia, katatonia, and melancholy with stupor is very close, and it is only in typical cases of the respective forms that there is a well-pronounced difference between them

CIRCULAR INSANITY (*Folie circulaire*) is a form in which mania and melancholia alternate, sometimes with intervals of a few days, or a week or two, of apparent sanity; usually the cycle is completed in a month or six weeks. The alternating condition often partakes more of dementia than of melancholia

The contrast between the physical symptoms of the respective mental states is equally striking. Thus, so long as the depression lasts the pulse is small and feeble, the skin is chill, and dry, the bowels are sluggish, and the appetite is indifferent though a sufficiency of food is generally taken, while on the other hand, an exaggerated activity of all the bodily functions is usual during the period of excitement In the latter state the temperature exceeds the standard of health whereas in the former it is below it. When the alternations are fully established, this form of insanity is very frequently incurable.

Katatonia is the name which has recently been given to a variety of circular insanity, in which physical phenomena of a very varied kind occur. They are associated more particularly with the depressed or melancholic stage of the disorder. The most characteristic features are epileptic fits and cataleptic states, which may coexist with stupor or profound melancholia; sometimes convulsive seizures are amongst the earliest symptoms of the disorder. After weeks or months of this mental and physical torpor the patient emerges from it, and often passes into a condition of exaltation, or at least of excitement, in which he assumes histrionic attitudes and, as has been said, speaks and acts dramatically. Hallucinations of sight and hearing are now manifested, and it would seem, at least in some cases, that the mind was active during the preceding stage: thus one patient who had been for months cataleptic, afterward told the writer that in acting as he had done he was obeying the commands of the Almighty. While the mental depression lasts there are a sluggish circulation, coldness and blueness of the surface, and occasionally œdema of the extremities; defective sensation is also a prominent symptom, and many patients are inattentive to the calls of nature. This state gradually gives place to quickened but often irregular action of the heart, and to improvement in the general tone of the system, concurrently with which there is, as already indicated, greater though abnormal activity of mental function. From this condition there may be progressive and complete recovery, or the patient may relapse into mental torpor and catalepsy with or without convulsive seizures; but before this recurrence there is in many cases an intervening period, it may be of almost full restoration to mental health, or, on the other hand, of acute mania. The elements of the morbid cycle vary greatly in different cases.

PARTIAL EMOTIONAL INSANITY.—In the disorders described under monomania partial derangement of the intellect is the most prominent feature. But insane feeling, usually fear or apprehension, limited to certain positions or surroundings, may be the chief expression of the psychical disturbance. One variety of this state is a dread of being alone in a wide space—in the country, for instance, or in an open market place. To this the name of *agoraphobia* has been applied. The subject of it if alone, say in a public square, is seized with intense dread, his heart palpitates violently, he becomes giddy, chill perspiration bedews his face, the houses and other objects seem to whirl round him, and, to prevent himself from falling, he leans against the wall, or crouches to the pavement, or clutches at a passer-by. Should any one take his arm and lead him into a small apartment, these sensations quickly subside and he feels quite well.

But the apprehension may be of quite an opposite kind, namely of a confined or shut place, and this bears the name of *claustrophobia.* The sufferers from it experience a distress equal to that just described if in a closed room, at least when alone, but are at once relieved when the windows and door are opened. Some people have a morbid dread of society, others of being alone; the former has been designated *anthropophobia,* the latter *monophobia.* To the intense fear which some endure while a thunderstorm lasts, the name *astrophobia* has been given. The latter varieties of emotional weakness are perhaps scarcely to be regarded as distinct forms of mental disorder.

More deserving of a place in this category is a morbid fear of pollution, which is the prominent symptom in some cases. Those suffering from it will refuse to shake hands with others, or even to touch them lest they should acquire some contagious disorder or be somehow contaminated by the contact. On being reasoned with they may tacitly acquiesce in the statement that there is no reasonable ground for their apprehension, but notwithstanding this admission, they will probably proceed to rub or wash their hand or other part which may have been touched. This mental condition is called *mysophobia.* The writer has met with an apprehension of an opposite kind, where the dread of the patients was that they themselves would defile others by their touch. In these latter cases more particularly there is a tolerably clear basis of delusion, as there is also in another of the "*phobias*" which has still to be mentioned—that of syphilis; and though grouped together here on account of their distinctive features, they might correctly be classed with other monomanias of the intellect.

IMPULSIVE INSANITY.—A tendency to act under insane impulses is a feature of the acute forms of mania and melancholia, particularly the former. Besides this, however, there are varieties in which this disposition is the chief, and occasionally almost the only evidence of mental derangement. Generally there is only one kind of impulse in the same patient, but there may be more than one, and the one may alternate with the other. The suicidal and the homicidal are the most common and the most important, and bear the names of suicidal and homicidal mania, although this last form is rare, and recently its very existence has been questioned by some authorities.

Similar morbid impulses to steal and to set fire to houses, etc., are known respectively as kleptomania and pyromania. But homicidal and other criminal acts are much more frequently the results of delusions, and more particularly of "voices" that may seem to the victims to come from Heaven, requiring implicit obedience from them as a sacred duty.

The impulsive tendency is not unfrequently manifested in persons respecting whom no suspicion of mental defect is entertained by others, in prompting to break large sheets of glass, to interrupt public speakers in their addresses, and to other actions which the patients know full well to be wrong, and struggle against with all their might, and fortunately almost always successfully. In some who are troubled in this way the writer has found other indications of derangement in the nervous system—one which was much complained of being a "springy" feeling in the feet, as if they were made of India-rubber. This sensation was experienced every few steps in walking, and when severe passed up to the head, producing a giddy feeling. Another troublesome symptom was involuntary starting of the limbs in going to sleep. In all these patients the cause appeared to be mental strain. But the enfeeblement of will may be manifested by phenomena of a very different kind. A case, for example, is recorded by Hammond, in which the patient, an intelligent gentleman, would spend an hour or two in determining whether he should take off his coat or his shoes first in undressing for bed, and frequently he would fail and require to summon assistance: his morning experience was similar; he would sit for half an hour with his stockings in his hands, unable to determine which should be put on first. French writers have named this disorder, "folie du doute." In other cases similar difficulty has been experienced about the raising of a glass of water to the head, crossing a gap in a line of houses, and many other matters.

MORAL INSANITY.—Sometimes the moral powers of the mind are affected in a marked manner, while the intellectual are but little disturbed. This condition has been called *moral insanity.* Those in whom it is seen have usually a strong hereditary bias toward mental disorder, and may have previously suffered from it in one of its more complete forms—

particularly mania. Pure cases of this variety are rare: still they are met with occasionally. The symptoms are lying, stealing, cheating, mischief-making of all kinds, and a disposition to violence—these being opposed to the patient's former character. In one characteristic case, long under observation, besides the state just described, there was further evidence of morbid change in the brain in partial hemiplegia. This designation—moral insanity—is objectionable, and should be avoided by medical witnesses in courts of law; if required to define the condition, it is better to speak of "partial insanity."

COMMUNICATED INSANITY (*Folie à deux, Folie communiquée*).—As indicated by the title, this variety of mental disease arises from close association with an insane person. It occurs most frequently in women. The writer recalls three cases of sisters in each of which the insanity of one of them had apparently this origin, the imposed and original forms being identical or nearly so. In two of the cases there were hallucinations of hearing and delusions of suspicion, in the third the delusions were of an amatory kind. The sisters lived apart by themselves, except in one instance, where they resided with their brother and widowed mother. It has been held that in such cases the one first affected, having more force of character, either natural or acquired by disease, than the other, impresses her morbid ideas on her companion, who gradually assimilates them till they become part of her mental constitution. This, though usually the order of development, is not always so, as in one of the cases referred to the more vigorous of the two was the last to succumb. Though the communication is generally to only one individual, it may be to two and even more members of a family. In almost all the recorded cases the sufferers were closely related to each other, so that in all probability there was a hereditary disposition to mental disease. In this connection it is worthy of remark that it has not been clearly established that a larger proportion of the attendants in lunatic asylums become insane than of other classes of the community, though it is probably somewhat higher.

The insane themselves do not often acquire each others' delusions; instances of that kind are, however, of occasional occurrence. Thus, there is at present a patient in the asylum under the writer's charge, who for many years has entertained the delusion that there is a peacock in her head. For some months another patient of good general intelligence, who had insane ideas about money, was much beside her at work. The latter, while still adhering to her fancies respecting wealth, was found to have adopted her comrade's peculiar craze and even in an exaggerated form, for she insists that not one but two or three peacocks are in her brain.

Relation of Various Diseases and Functional Disorders to Insanity.—In susceptible persons certain states of the system, both physiological and pathological, are sometimes the immediate causes of insanity; or if in some cases they are not the sole agents, they so operate that trifling, and of themselves altogether inadequate, irritations, mental or physical, become capable of inducing derangement of mind. Arising in such systemic conditions, the forms of mental disorder acquire distinctive characters, which have given rise to special names indicating the supposed causation. Thus there is an *hysterical mania* in which the strange imaginations and peculiar deceptions characteristic of hysteria are associated with excitement, slight incoherence, morbid craving for sympathy, hallucinations and delusions, and erotic displays, as well as generally with some of the physical symptoms of the disease, such as the globus hystericus, hysterical convulsions, and inability, or alleged inability, to pass urine.

At the establishment of the menstrual function, excitement with delusions and a disposition to impulsive violence may appear, constituting the "mania of puberty." This generally passes away in a few days or weeks, and seldom continues after menstruation is regular. At the same period of life, in both sexes, instead of ordinary acute mania, that already described as simple mania, or, as it is sometimes called, reasoning mania, may arise, but the form may be a moral perversity manifesting itself by a suddenly acquired disposition to lying, cheating, stealing, and the like,—this state being the result of disease, though very often not so considered. It is not unfrequently preceded by marked mental depression, with distinct suicidal attempts. Hallucinations of hearing and sight, and also delusions, spring up in the course of the disease, but it may not be till after months or years have passed, during which there may be nothing but the moral obliquity and waywardness of conduct to indicate the presence of mental aberration. It is to this form that the term hebephrenia has been applied. It is much more likely to be of long duration than the maniacal condition, and too often gradually involves the mind generally, passing ultimately into incurable insanity.

Between puberty and the full development of the body, mental disorder may arise from various causes. This period extends over a number of years, but is shorter in women than in men, for the former arrive at maturity sooner than the latter. It is held by some authorities that the derangement of mind which then occurs has special characters owing to the activity of the processes of growth, especially those related to the sexual functions; they have named it the insanity of adolescence. Mania is the form that usually presents itself, and the symptoms are, as a rule, acute, and marked by vigorous demonstrations. Hallucinations relating to the generative organs, or at least of an amative nature, are common, but further than this there is nothing distinctive in the features.

Disorder of the uterus and ovaries at any time during the years of their functional activity, especially when there is amenorrhœa, is not an uncommon cause of other varieties of insanity. The distinctive delusions that spring up then have often reference to these organs or to their functions; thus the sufferers may fancy that they give birth to children, or that their persons are violated while asleep. Nymphomania may arise from the same source; the particular feature in it being a disposition on the part of the patient to make indecent advances to the other sex, and even to make shameful exposure of the person. A distinction has been drawn between this state, which is regarded as due to the general disturbance of the nervous system from a peripheral irritation in the sexual organs, and that named erotomania, in which the organs of generation are apparently healthy, and the morbid action is believed to be entirely in the brain. The mental symptoms are really alike in both, though it has been held by some that, as opposed to nymphomania, the language and conduct in erotomania are pure, and do not greatly transgress propriety. In the male sex a condition corresponding in the character of the acts and in the general psychical features is known as satyriasis. It is, however, to be borne in mind that delusions connected with the organs of generation in both sexes may exist with perfect propriety of conduct, and also that amenorrhœa is a common symptom in insanity due to other causes.

At the close of menstruation one of the many troubles that are apt to arise is mental disorder. It occasionally assumes a maniacal character, but much more frequently the form is melancholia, with delusions and a disposition to suicide. It has been named "climacteric insanity." The symptoms are those of ordinary melancholia, a morbid fear of having done something wrong or of impending evil, with impulsive tendencies to homicide as well as to suicide, being somewhat prominent features in many cases. It is rather an unfavorable form of mental disease; still, recoveries are not rare.

It is thought by some that *excessive venereal indulgence*, especially in the newly married, may suffice to overthrow the mental powers in susceptible persons, inducing what has been designated sexual mania; but other direct causes probably always combine with it in the production of the insanity, and there is nothing distinctive in the symptoms.

The vice of masturbation, in both sexes, sometimes induces an intractable form of mental derangement. Early symptoms springing from the vile habit are an unwonted shyness and an evasive look, irresolution of character, and a disposition to be alone. By-and-by a general feeling of fear and suspicion of others arises, with sulkiness of temper; then come hallucinations, such as that the victims are acted on through the walls by electricity, that their food is poisoned, that they are tormented by evil spirits, etc.; great religious fervor is common, especially in women. There is, however, much variety in the morbid phenomena. Thus the writer has met with cases in which feelings of pride and self-consequence were well marked, with grandiose delusions and an offensive forwardness of manner. In most cases the intellect gradually becomes weak, and after an indefinite period the unfortunate sink into dementia. General nervous symptoms, such as palpitations and feeling of sinking at the heart, are usually associated from the beginning with the psychical disturbance. Should the masturbation be stopped before the intellect is much impaired, mental health may be restored; but if once insanity has been distinctly established, recovery is the exception, rather than the rule, as the vice is then seldom mastered.

The influence exerted on the mind of women by the sexual system is evinced in other ways than those mentioned. The majority of women are more susceptible and impressible, and are sometimes very irritable during the flow of the menses. *During healthy pregnancy*, also, cravings for extraordinary articles of diet are very common. These are usually innocent enough, but not always, as when a woman, overcome by the sight of the brawny arm of a baker who worked opposite her dwelling, compelled her husband to offer him money to allow her to take "one bite" out of it.

Mental disease occasionally appears during utero-gestation, and is apparently dependent on it; this is known as the *insanity of pregnancy*. It is not common, and is more prone to occur at a late than an early period of gestation. Though mania and monomania are both met with, melancholia is the usual form, refusal of food, and a disposition to suicide being sometimes marked features. The majority of such patients recover soon after delivery, but a large proportion continue insane.

In severe labor, during the passage of the head through the os internum, and also through the vaginal orifice, it occasionally happens that the patient falls into a state of semi-conscious delirium, lasting for a few minutes. The writer has seen a mild attack of mania arise during severe labor resulting from contracted pelvis, which passed away in two days after delivery. This is a rare event.

The most important of all this group of disorders is that which occurs within two or three weeks after delivery, and bears the name of *puerperal mania*. The fourth or fifth day is the most common time for the appearance of the symptoms, though it may be at an earlier as well as at a later period. Sometimes the attack is very sudden, but generally for a day or two previously the patients are unusually excitable, give little or no heed to their infants, sleep little or none, complain of pain and a feeling of constriction in the head, and have often ocular disorders, such as flashes of light and double vision. They ramble in conversation, and talk more than in health; imagine they see objects; mistake the identity of people, and act foolishly. The pulse is also quick, and the skin may be hot. When the insanity is fully developed, the symptoms, both physical and mental, are all of an acute type, and the condition may even amount to delirious mania; but, fortunately, this is somewhat exceptional. It is a feature of the psychical state that the language used is often filthy and obscene. Aversion to husband and baby is a common, but by no means a constant, symptom. Under the influence of this feeling, mothers have in many instances destroyed their infants. Cases are also met with, beginning within a week after childbirth, in which the condition would be more correctly designated acute melancholia than acute mania. Early in the disease, as a rule, both the lochial discharge and the mammary secretion are arrested; but in mild cases the latter, and even both, may continue to flow, though in reduced quantity. Occasionally the urine is found to be albuminous. It is well to remember that there is also sometimes metritis or endometritis, as these are apt to be overlooked through the greater prominence of the mental symptoms. First confinements are more liable to be followed by mania than subsequent ones; but it is not uncommon for a woman to have an attack after several successive births. Good recoveries, as a rule, are made after the first two, or even three, seizures; but should there be any more, the mind generally becomes permanently weakened. Although the maniacal is by far the most frequent form of mental derangement, melancholia occurs occasionally.

There is yet another important variety connected with the puerperal state—*the insanity of lactation.* It occurs after some months' nursing, or immediately after the weaning of the infant, and is largely due to the drain, through the mammary glands, having proved too much for a feeble or susceptible frame. As might be expected, the patients are weak, and usually anæmic. Melancholia is the type of disorder that is most frequently developed, but other forms are occasionally seen. In this variety, also, a disposition to destroy the infant is not uncommon; besides this, a tendency to suicide is sometimes manifested. Exophthalmic goitre and functional cardiac murmur have been noticed in a few cases, particularly where the mental derangement presented maniacal features. The prospect of recovery from this, as from the preceding variety of puerperal insanity, is very good, at least from first attacks; a small percentage, however, lapse into incurable insanity.

Alcoholic Insanity.—As already stated, "transitory mania" may be at least directly induced by alcohol; but besides this and the much more common disease, delirium tremens (see p. 256), there are other disorders resulting from the same powerful agent, which have yet to be noticed. (1) Habits of intoxication, along with the ordinary symptoms of chronic alcoholism, often induce a state of mind characterized by gloomy suspicion and hallucinations of hearing. This condition has prompted to homicide as well as to suicide in a number of cases. (2) Excesses in alcohol may cause mania or melancholia of an ordinary acute kind, except that the delusions partake of the delirium tremens character, and that the attacks themselves are of shorter duration. Though cases of this kind are occasionally seen, they must be regarded as rare. (3) Progressive dementia, accompanied by a form of general paralysis, is a rather common result of prolonged drunken habits. It not unfrequently occurs in women who have been long addicted to secret tippling. The symptoms closely resemble those of ordinary general paralysis, and in some cases the disorders can scarcely be distinguished from each other. The diagnosis will be considered in connection with general paralysis. (4) There remains the condition known as dipsomania or oinomania. The craving for drink in this state is insatiable, and no consideration whatever deters the victim from seeking its gratification. Three varieties have been distinguished—the acute, the chronic, and the periodic. The acute, which is rare, has been noticed after hemorrhage in the puerperal state, in recovery from fevers, after excessive venereal indulgence, and in some forms of dyspepsia. It often passes away in a few days, and shows no disposition to return. The chronic is the form that exists in the habitual drunkard. In him the craving for alcoholic stimulants is constant, and is often strongest in the morning. He experiences a sensation of sinking at the stomach, with a feeling of mental depression amounting even to misery when not under their influence. Great moral depravity is generally a marked feature of character; and the writer has observed that in women this is usually associated with much pretence or show of religion. The periodic variety is not common. It occurs in paroxysms of exceeding severity, ordinarily with intervals of some months between them. All these varieties, but particularly the last one, are not unfrequently the outcome of the "insane temperament."

The poison of syphilis in the constitution may give rise to different forms of associated disorder of the brain and mind. Thus, after a prodromal period of irritability, slowness of mental action, and occasional confusion of ideas, accompanied by shooting pains in the limbs and numbness of the head, there may be one or more convulsive fits, followed by mania or melancholia; or instead of either of these forms of mental derangement, the symptoms mentioned may be succeeded by a hysterical condition which rapidly declines into dementia more or less complete. Sometimes the premonitory stage is succeeded by a state which bears considerable likeness to general paralysis. There may even be grandiose delusions likewise, though this is not common. The defects in articulation and the paresis of the voluntary muscles generally are very similar in both cases. In the syphilitic form we find both greater rapidity and irregularity in the progress of the symptoms. The sensory phenomena are likewise much more marked, such as pains in the limbs, numbness, and formication; and these, as well as the motor symptoms, are more apt to be unilateral at an early stage of the disease. The retinæ are less frequently affected: and should there be inequality of the pupils, it will probably be found that some of the ocular muscles are also paralyzed. The convulsive seizures are more disposed to be partial, both as regards the implication of consciousness and the muscles involved, than in the case of general paralysis, and the attacks are also more frequently followed by paralysis of the convulsed members; this may or may not be persistent. The evidences of constitutional syphilis in nodes, enlarged glands, cutaneous eruptions, etc., with a history of contagion, will of course materially aid the diagnosis. It is to be observed that insanity, as well as other forms of disease in the central nervous system due to syphilis, is most apt to occur in cases where the secondary symptoms have been slight or at least not marked. It does not follow from this that the sufferers from constitutional syphilis, with pronounced external symptoms, have an immunity from mental disease. The writer may mention, in illustration of the contrary, that he has had cases both of mania and dementia under his care, in which there was necrosis of the bones of the skull and of the nasal cartilages, the latter conditions at least being dependent on the action of the syphilitic poison.

Besides a real there is also a spurious syphilitic insanity, which bears the name of *syphilophobia*. The distinctive feature of this disorder is an intense fear in the mind of the sufferer that syphilis has been acquired, every trifling papule being regarded as convincing evidence of its presence. In other respects the mental state is that of acute or chronic melancholia. It is most frequently met with in persons of high moral tone who have once or twice fallen into irregularity of conduct.

Epileptic Insanity.—When epilepsy has continued for some years it induces mental defect, and this may occur much sooner if the fits are frequent, but if they are at long intervals the mind may remain unaffected. In some cases the *petit mal* would appear to exert a more baneful influence on the mental powers than the full convulsive seizure; but this, though asserted by some, is not always the case, as the writer has seen patients subject to the latter form in whom dementia rapidly supervened, and others who had suffered from epileptic vertigo for years, at short intervals, and still retained considerable mental vigor. Irritability of temper and weakness of memory are the first indications of the mind being involved, but in course of time all its powers are implicated, and ultimately the wreck is complete. But instead of a uniform, progressive degeneration, it often happens that, after a single seizure or a number in succession, an acute maniacal attack occurs, in which there is generally manifested a disposition to violence, and occasionally also to suicide in the same patient. Murders have been committed by epileptics while in this condition. Hallucinations and delusions are usual in the course of paroxysms, and some patients manifest marked religious feeling at these times more particularly. The mania may pass away in a few minutes or in an hour or two, and in any case seldom lasts longer than four or five days, though it is apt to return on the recurrence of the fits. The last feature, however, is very irregular, and, in illustration, the writer may allude to a patient under his care who had an attack of epileptic mania about five years ago, and has continued free from it since, while there has been no abatement of the convulsive seizures. Though the mental disorder generally follows the convulsions, it occasionally precedes them, and in some cases would seem to take their place, the entire paroxysm being apparently mental. In some instances epileptics fall into an automatic state without having had a convulsive attack, and then perform actions which, though usually irregular and destructive, may be definite and correct in themselves, but only wrong as to time or place,—the patients being quite unconscious, and incredulous when told of their conduct on their recovery. This state is generally very brief, lasting only for seconds or minutes, but it may continue for half an hour, seldom longer.

The *poison of rheumatism and gout* in the system may induce mental disorder which sometimes amounts to insanity. Such attacks are often of a metastatic character, the joint affection being in abeyance during the continuance of the mania, which is the usual form of derangement in these circumstances. The attack commonly passes away within three or four weeks. A similar event may occur in the course of *asthma.* For example, a person who had been a martyr to the spasmodic form of the disease for nearly twenty years, rather suddenly became maniacal; the asthma then entirely disappeared, and did not trouble her during the six weeks that the insanity lasted; but when the latter subsided, the asthma returned in all its former oppressiveness. The writer has also seen the *poison of lead* induce an attack of maniacal delirium, which continued for a few days in one case, and for a month in another; there were also convulsions in the former case, but none in the latter; the characteristic blue lines on the gums were present in both.

The feeling of sinking and general discomfort experienced by those habituated to the *use of opium*, in whatever form and way it be taken, when they are not under its influence, occasionally attains to such a degree of intensity that the condition may even amount to insanity. The unfortunate sufferers who have arrived at this stage, after the effect of the drug has died away, are wretched, miserable, and may even be suicidably disposed. The writer has known it necessary to commit such a one to an asylum: but this is quite exceptional.

Phthisical Insanity.—In the later stages of phthisis pulmonalis mania is occasionally developed. The symptoms are generally very acute, even attaining the severity of those of delirious mania: the attack often terminates in fatal exhaustion. In an early stage of the same disease, or of general tuberculosis, Dr. Clouston has pointed out that a morbid mental condition of a different character is sometimes present. It is characterized by unfounded suspicion and irritability, with occasional bursts of excitement or fits of depression. This mental state is, however, not so common as an opposite one in tubercular disease of the lungs, in which the patients are sanguine and unduly hopeful, even when their illness is going on to a fatal issue. But the psychical condition in the latter case is not insanity.

The excitability which is an ordinary symptom of *Graves's* or *Basedow's disease* (exophthalmic goitre), may increase and be accompanied by incoherence and violence, so that mania is established. The attack commonly subsides in a few days.

One of the characteristics of the peculiar widely diffused disease of the tissues, to which Dr. Ord has given the name of *myxœdema*, is a dulness of perception and a general torpor of the mental faculties. Dr. Savage has described cases in which there were also present delusions of suspicion, but the number hitherto observed is too small to warrant the conclusion that these may be regarded as typical of the insanity that has this origin.

Tape-worm in the intestinal canal may induce mania through the action of the peripheral irritation on the brain, just as it occasionally gives rise to epilepsy.

Blows or falls on the head are not unfrequently followed by insanity. The form varies: mania and dementia are both met with, as also a combination of the two. The condition is hopeful or otherwise according to the amount of injury sustained by the brain.

When distinct insanity is produced by *sunstroke*, or follows *typhus fever* or other of the *exanthemata*, although mania may be the primary character, dementia generally soon ensues; or the insanity may be of this form from the first. The prognosis in these cases is generally unfavorable. But this is to be distinguished from a condition of mental excitement of moderate severity, accompanied by hallucinations of hearing and sight, which occasionally arises somewhat suddenly in an advanced stage of these diseases, and also in pneumonia, but usually passes away in a day or two, or even sooner. This has been lately described as a form of insanity; but observation of such cases would rather lead the writer to designate it as an acute form of delirium, symptomatic of the associated disease, though not always of a state of collapse, as was believed by Dr. H. Weber, who first directed attention to this variety of mental disorder.

The catalogue of physical diseases or causes, on which insanity may be more or less dependent, has not yet been exhausted. In fact, it would seem that a morbid condition of any organ, in persons of weak, susceptible nervous systems, may so disturb the functions of the brain that mental derangement may be the result. Thus it has been developed in connection with cardiac, intestinal, hepatic, and vesical diseases. There is little uniformity in the symptoms of the insanity which arises in this way; and it would rather appear that the character of the mental disturbance is more dependent on the general condition of the system as to strength or weakness, and on the nature of the hereditary bias, which so commonly exists, than on the special organ whose morbid state may have been the exciting cause of the cerebro-mental disorder. At the same time it may be said generally that disease in the abdominal organs, and especially in the liver, is more apt to be associated with melancholia than in any other form. It has been alleged that when disease of the heart and unsoundness of mind both exist in the same person, melancholia is the form most commonly found with mitral lesions, and mania with aortic disease; but the uniformity of these associations is not established. In considering the concurrence of disease in these organs with insanity it is always to be borne in mind that this may be altogether accidental, or that their morbid state may be due to that impaired nutrition of the central nervous system on which the insanity itself depends.

General paralysis, also called "general paresis," and sometimes "paralytic dementia," is a very important and a very fatal form of insanity. It is peculiarly a disease of middle life, seldom occurring under thirty or above sixty years of age. It is at least four times more common among men than among women. Its ordinary duration is from two to three years; but it may terminate fatally in six months, or be protracted for six years or longer. When the disease is developed, in nine cases out of ten there is exaltation of feeling, though this is occasionally preceded by a brief period of depression; and in a few exceptional cases there is melancholy feeling throughout its whole course. After the brief preliminary stage of depression has passed away, if it existed at all, the patient becomes restless and flighty in his manner, and impatient of control. He spends his money foolishly, and launches forth into wild speculations. Then the characteristic delusions arise. He asserts he is worth millions of money, is as strong as Samson, and is king of the universe; any or all of these or similar extravagant notions may be entertained. Even in this stage, the defective memory and the inability to follow out any subject of thought, reveal the enfeeblement of intellect; and emotional weakness may also be evident in the aspect, and the tendency to bursts of passion if in any way opposed. At this period there is also sometimes a disposition to indulge to excess in alcohol, and to be indecent in conduct before the opposite sex; occasionally a proclivity to steal is manifested. The delusions usually persist to near the fatal close, or at least so long as advancing defect in articulation permits of their being recognized; but even *they* would seem sometimes to be involved in the utter wreck of mind in the final stage. In the earlier period of the disease, maniacal excitement, with destructive tendencies, is very common; and it occasionally happens that a maniacal attack occurs at the very onset. In some rare cases expansive delirium yields to hypochondriacal feeling, and in others, equally rare, the disorder assumes the circular type.

Indications of the paralysis appear in most cases shortly after the onset of the psychical disturbance; but it is to be observed that at first the condition is ataxic rather than distinctly paralytic. The two sets of symptoms frequently, however, occur simultaneously, and the ataxic may even precede the mental disorder. These indications are first noticeable in tremor of the upper lip, especially when the zygomatici and the elevators of the lips are in action. Certain movements of the tongue are likewise not performed with their natural precision. The patient has thus difficulty in articulating words in which there are several labials or liquids—tolerable, February, constitutional — for example. The defect seems a thickness or slight stuttering, like that of a person in the first stage of drunkenness; and it may only be observable at this period when the patient is under emotion. It is not usually till after some weeks or even months have elapsed that the muscles of the lower extremities are involved. Then there is observable at first a peculiar cautiousness of gait, with slight uncertainty and unsteadiness, most distinct when about to turn after walking a few paces. The arms are often late of being much implicated, but ultimately they do not escape. As the disease progresses, the articulation becomes more and more indistinct, the tongue while being put out is projected in a jerky manner, and a fibrillar movement is observed in its substance. Similar tremulous, irregular contractions occur in the muscles around the mouth when called into action. All the muscles of the face are involved, and a characteristic hebetude of expression is acquired. Though both sides are generally affected pretty equally, the paralysis occasionally is more pronounced in the muscles of the one side than the other. When the disease is far advanced, the muscles of deglutition and respiration participate in the increasing ruin, and it is not seldom that death occurs from choking by a morsel of ordinary food. In most cases after it has reached its middle stage, epileptiform seizures and attacks of cerebral congestion occur occasionally: but though more common at this and the later periods, the convulsive attacks are not confined to any stage; they may occur at the commencement of the disease. Instead of involving the whole body, as is usual, the seizures may be partial, resembling those of syphilitic origin. The pupils are very generally unequal: in some they are minutely contracted; in exceptional cases they are normal. There is often hyperæmia of the retina in the early stage, and neuro-retinitis, quickly passing into atrophy, when the distinctive symptoms of the disease are obvious: but there are many exceptions to this rule. Loss of the sense of smell has been stated to occur early in the disease, but according to the writer's observation this is certainly not a uniform symptom. Auditory hallucinations are occasionally observed, particularly when the disease is of syphilitic origin. Defect in cutaneous sensibility is not very marked at first, but later its existence is clear; local hyperæsthesia may coexist with it. The muscular sense is also impaired; and electric contractility suffers at an advanced period. When the disease is distinctly progressing, the evening temperature is often from 2° to 4° F. above the normal. Convulsions and cerebral congestion are marked by a still greater increase of heat. "Hæmatoma auris" not unfrequently occurs along with the more acute symptoms. In a few cases, during the course of the disease, there are remarkable remissions, extending over a number of months, and these may be so complete that a cure may be supposed to have been effected; but unfortunately, with scarcely an exception, there is a relapse, leading ultimately to a fatal issue. The progress of the disease is slower in women than in men.

In private practice general paralysis is very often overlooked in its early stage. In a few exceptional cases the diagnosis is difficult, but in the great majority, when the symptoms are looked at together—for no one by itself is pathognomonic—it is easy, and a mistake should not occur. The following are the leading symptoms, mentioned in their order of importance: Difficulty in articulating certain words, and tremor of the upper lip; emotional weakness with exaltation (it may be necessary to contradict the patient before these are properly manifested); grandiose delusions; general feebleness of judgment and memory; unsteadiness of gait; inequality of pupils; hyperæmia of retina, followed by atrophy of optic disk. Sometimes the intense self-feeling, as well as the exaltation, come out most distinctly in writing, and it may therefore be advisable to ask the patient to write his views on any subject in which he may seem to be particularly interested. It will also be noticed that in many cases there is an omission of syllables or words, or a repetition of them.

The disease for which it is most apt to be mistaken is a form of paralytic dementia due to long-continued excesses in alcohol; and certainly it is occasionally very difficult to distinguish between them. This is not surprising when it is remembered that habits of drunkenness are sometimes associated with over-indulgence in venery in the production of real general paralysis. The distinguishing features of the alcoholic variety are: Stupidity with depression of feeling, rather than emotional exaltation with intellectual weakness and extravagant delusions; belief in present or past hallucinations of the alcoholic type; no inequality or other abnormnal state of pupils; defects in articulation partaking of a drawl as well as of a stutter; absence of retinal change except congestion at first, which rapidly subsides; the whole aspect one of obtuseness rather than of exaltation combined with feebleness. Still, cases do occur now and again where the paralytic and mental symptoms are very much alike in both forms, and there may be nothing but a history of habitual drunkenness, and of a former attack or attacks of delirium tremens, with normal state of the pupils and only slight congestion of the fundus of the eye, on which to base a rather doubtful diagnosis of alcoholic dementia.

Monomania occasionally bears a degree of resemblance to general paralysis in its early stage. The delusions may be equally extravagant in both, but in the former there is less variability in their character; the memory is good, the judgment in other respects may not be obviously impaired, and altogether there is greater mental vigor. Besides, the ataxy or paresis of the muscles of articulation, emotional weakness, etc., are not present.

Locomotor ataxy in its ordinary form can scarcely be mistaken for the disease under consideration. But the pathological changes in the cord found in ataxy would seem occasionally to extend to the medulla oblongata and higher parts of the brain, inducing defective articulation and mental disorder. In the ataxy of general paralysis the knee-jerk is usually present. Delusions of grandeur are not a common feature of insanity arising thus.

It will suffice merely to mention that the mental and physical degradation, which are often found in epilepsy of long standing, occasionally bears a general resemblance to a somewhat advanced stage of general paralysis, in which, as already stated, epileptiform seizures are common; an inquiry into the history, besides a study of the symptoms, should at once establish the diagnosis.

Idiocy.—Idiots, considered pathologically, have been arranged by Dr. Ireland into ten different groups; but looked at broadly and generally, in relation to their symptoms, they may be divided into two great classes—the apathetic and the agitated—between which there is every grade. Individuals of the lower types of the first class have often awkward, clumsy, and ill-proportioned bodies and coarse features; lips thick and everted; teeth irregular and decayed; gums swollen; ears ill-formed and large. Their heads are in general of good size, and are sometimes larger than the average; but they are misshapen and not unfrequently flattened in the occipital region. Mentally they are often gloomy, generally passive, but sometimes passionate and dangerous. The agitated class are quick and flighty, and run about laughing, crying, and gesticulating. They are subject to bursts of passion, and are often pugnacious. They have in general abnormally small but well-formed heads. In both classes attention and perception are exceedingly feeble; there is little memory and less judgment; and the will is imperfect—their acts being usually the results of impulses originating in their sensations. Occasionally there is an exceptional development of a particular faculty or talent, most frequently that of music. Speech is very defective, and many cannot articulate at all; squint is common; and a large proportion, especially where the condition is congenital, have what has been called the saddle-shaped palate—that is, a palate whose arch is considerably higher than the normal. A large proportion have a tendency to be of dirty habits, and occasionally the sexual appetite is very strongly developed.

Idiots, as well as imbeciles, and particularly the latter, may have attacks of melancholia, or monomania, but most frequently of mania. The acquired disorder may pass away, leaving the patient much as before the seizure, or it may continue to some extent, modifying the original condition.

Dr. Ireland holds that even in early infancy idiocy may be recognized by the slowness or awkwardness of the child's motions. He says: "If laid flat upon his face, he will sink upon the floor, whereas a normal child of a few months will try to right itself, or cry for assistance." In the writer's experience, however, this is not a reliable test in all cases. When a little older, the wandering, unsettled eye, the inability to fix the attention, the slowness and inaptitude to learn, and the general vacancy of expression, reveal the mental defect. The state of the palatal arch, when present, is a valuable aid to diagnosis.

The Diagnosis of Insanity from Delirium.—It is first of all to be noticed that in certain cases there is no real difference between insanity and delirium; thus mania, occurring in the course of pneumonia or in an advanced stage of phthisis pulmonalis, is sometimes simply delirium of an acute type. However, cases in which the two states approximate so closely are not very common, and in general the distinction is quite obvious, being marked by definite characters. (Compare p. 255.)

Delirium is very generally preceded for some days by other and more characteristic symptoms of the disease on which itself is dependent. Should that be inflammation of the lungs or brain or other leading organ; or severe injury of extremities or other parts, inducing inflammation; or one of the specific fevers, or smallpox, or other animal poison in the system; ordinary symptoms of the particular morbid state will usually have been manifest *before* the mental disturbance appears. The character of the delirium in the first instance, and also often throughout its entire course, is in most cases quiet rambling or incoherence, and these symptoms are most apt to show themselves at night, especially when the patient is drowsy, and no one is addressing him. Associated with it there are also frequently hallucinations, particularly of vision. Occasionally, however, the excitement is greater, and the patient can with difficulty be controlled. Should it spring up after injury in one of drunken habits, we have often much excitement and violence, along with fear and hallucinations. This state frequently partakes more of ephemeral mania than of ordinary delirium tremens. But though delirium is usually a late event in the disease of which it is symptomatic, occasionally, and particularly in children, it occurs early in its course; in that case, however, it is accompanied by a temperature markedly elevated, and by other acute febrile symptoms.

The physical symptoms that accompany delirium are commonly high temperature, very quick pulse, furred dry tongue, parched skin, injected conjunctivæ, scanty high colored urine, etc.—in fact, such as indicate the febrile state. These, it will be observed, do not correspond with the condition in the most common form of acute mania, where the febrile action is slight, if there be any at all. In establishing the diagnosis no symptom is so reliable as the temperature. Indeed, the determination of this point may be regarded as of so much importance that it might be laid down, as a rule, that in any case where the temperature is distinctly above the normal, as ascertained by the thermometer, or even by the hand, if the thermometer cannot be used, the examination should not be regarded as complete until it be ascertained if inflammatory action in one of the leading organs, or one of the continued fevers, does not occasion the mental disturbance. In delirious mania, however, there is often elevated temperature with other febrile indications, but they are seldom so marked as in ordinary delirium. Further, in this form of mania the excitement, as a rule, is higher and more constant than in delirium, continuing without the least remission, or with snatches of sleep of not more than half an hour or an hour in duration, for days and nights together; whereas the excitement and incoherence of delirium generally vary considerably in their intensity, being often worse at night than during the day.

Much aid in the formation of the diagnosis will be obtained by the observation of the special symptoms of local disease, should these be present. It is probably most frequently in relation to the early stage of acute meningitis that doubt arises. In it there are generally injection of the eye and flushing of the face, intolerance of light and sound, considerable headache, vomiting, contracted pupils, pain and spasmodic movements in the extremities, and high temperature; and as the disease progresses, squinting, general convulsions, dilated pupils, etc.

It will be sufficient to mention that typhus fever has been mistaken for mania; the high temperature, parched skin, ferretty eyes, and eruption, with the history, should make the diagnosis clear.

From the observations that have been made, it will be understood that the diagnosis of delirium from the varieties of mania which it at all resembles, rests much more on the history of the illness and on indications of existing acute physical disease than on any very marked difference between the mental symptoms in the two conditions.

Mere drunkenness has been mistaken for insanity even by medical men. A little inquiry into the case, and the observation of the too familiar symptoms of intoxication should prevent such an error.

The mode of examining a person supposed to be insane is a matter of considerable importance. There is generally little difficulty where ordinary mania or melancholia are concerned, at all events when they are fully developed; it is experienced most frequently in the varieties of partial insanity. In some cases even the introduction to the supposed lunatic is no easy matter. No general rule of procedure can possibly be laid down, as this must vary according to the social status, the habits, the mental peculiarities, and many other circumstances. The frank bluntness of address that might suit a laborer would scarcely be acceptable to an educated gentleman. The writer's practice is generally—not in all cases—to drop the title of "Dr." and to be introduced as "Mr." It has seemed sometimes that the announcement of the medical title has at once aroused a feeling of suspicion and hostility, and rendered the inquiry very difficult. A few easy general observations may suffice to establish agreeable relations between the physician and the patient before the professional nature of the visit is revealed. This in the great majority of cases it would be unwise to try to conceal, as most patients would at once resent any attempt at deception. It will often, then, be advisable to state quietly to the patient that you are a physician; that you understand from his relatives that he has been somewhat out of sorts lately; that possibly it might be only supposition on their part, but it would allay their anxiety if he would kindly answer a few questions respecting his health. This being conceded, it will be well in the first instance to make some medical inquiries of an ordinary kind and then to extend the investigation to the special senses, particularly those of hearing and sight. Cautiously ask respecting noises in the ear, and if they resemble whispers or loud voices, and what they say; and in relation to the eyes, if motes or other unusual objects be seen, if they assume special forms, and if so, what they are like. Then lead the conversation on to matters relating to home and family, business prospects, religious views, etc. Of course, the particular line of inquiry will frequently be guided by information previously obtained from relatives and friends, though this in some cases is incorrect and in others is defective. It occasionally happens that near relatives who are constantly beside the patient are quite unaware of the existence of dangerous delusions. In most cases the general bearing and expression of countenance indicate the nature of the morbid ideas; and, especially where the history is imperfect, this guide will save an immense amount of trouble by at once suggesting the kind of questions best fitted to draw them out. The psychological physician should be skilled in physiognomy. Many useful hints in prosecuting the investigation are also frequently obtained by the observation of peculiarities of dress, oddities about the room, and sundry other things.

But perhaps at the very commencement of the interview the patient indignantly resents the idea that he is ill at all. Then the most judicious plan will sometimes be to sympathize with his indignation; to ask what could have made the relatives suppose that his health was impaired; and to inquire if it could be due to any plot or conspiracy, and if so, what may be the motive. This may bring out delusions of suspicion, which are common in cases where difficulty in the examination is experienced. Occasionally a lunatic who is very reticent in conversation will express his views more freely in writing, and in this way the existence of delusions may be ascertained.

These observations illustrate the general method of procedure; they cannot do more, as the investigation in each case ought to be based on the features which are peculiar to it. It need only be further remarked that, should the patient be melancholic, the inquiry ought always, if possible, to demonstrate the presence of a disposition to suicide when it exists, as it so often does in this condition. Generally the point may be determined by indirect questions, but occasionally it is necessary to ask the patient plainly if he is weary of life and contemplates self-destruction.

Family History.—As insanity is a highly hereditary disease, it is important to inquire respecting its existence in the family to which the patient belongs. But the inquiry should not be restricted to mental disorder, as it is now well established that, in the descent from one generation to another, various neurotic affections—such as epilepsy, chorea, hysteria, a disposition to habitual drunkenness, particularly in its paroxysmal form, etc.—are mutually interchangeable. (Compare p. 68.) Thus it is common for an epileptic patient to beget an idiotic or imbecile child; or conversely, the offspring of an imbecile father or mother, or of one who has been insane, or is of the insane temperament, may be epileptic or idiotic. The prognosis of the mental illness would be more serious if a strong hereditary taint were present; not that the prospect of recovery from an attack of insanity, which otherwise might be curable, would thereby be much, if at all diminished; for this is scarcely less frequent than where no such taint is in the constitution. There would, however, as an expression of the ancestral defect, be a greater tendency for the type of disease to be more grave from the beginning—showing itself, for instance, at first as a slight deviation from the normal standard, and then gradually merging into incurable insanity. As a further illustration of the constitutional vice, it is worthy of note that in patients who have recovered from one or more attacks, *recurrence* is particularly to be dreaded. Idiocy and imbecility are often transmitted from parent to child, though, as already mentioned, the morbid tendency may be transmuted into another neurosis in the descent. Consanguineous marriages, and particularly those of cousins-german, yield, it is generally, and the writer thinks correctly, believed, a larger proportion of idiots or infants with some mental defect than when no such relationship exists; but this conclusion is not yet determined with certainty. It seems, however, well established that if in this class of marriages there be a decided neurotic taint in the family to which the parents belong, the husband and wife both inheriting it, the defect will probably be intensified in the children. The establishment of puberty is very trying to the mental stability of those in whom a marked hereditary tendency exists, especially to women; so also are pregnancy and childbirth. Experience shows that, as a rule, the hereditary tendency is more prone to be transmitted from father to son than from father to daughter, and from mother to daughter than from mother to son. It is to be borne in mind that the existence of insanity in the family is often denied by the relatives. The inquiry is a delicate one, and should be carried out with consideration for the feelings of those concerned.

Question of Asylum Treatment.—If the medical examiner be satisfied that his patient is insane, he will next require to consider what advice he should give to the friends—whether he should recommend immediate removal to an asylum, or a trial of treatment at home, or, at all events, elsewhere than in such an institution; the matter is one of great practical importance, and is at the same time one sometimes very difficult to determine. Many considerations besides those of a medical character must be weighed in seeking to arrive at a correct conclusion. Thus it will be obvious that if the patient be wealthy, and have kind, judicious relatives, and if his house be in a retired situation and have private ground attached, it will not be necessary to insist on so early removal to an asylum as if he be a laborer living in a small house in a crowded neighborhood; for in the former case the patient already possesses, or can readily procure, most of the advantages which an asylum presents, but which the poorer man can have nowhere else. But though these points ought to form an important element in the judgment, the main grounds will rest in the character of the disorder itself. The indications derived from it, however, can only be stated in a general way. Should the insanity, though characterized by a considerable amount of excitement, be quite sudden in its onset, without distinct premonitory symptoms, the attack often passes away quickly; a sudden seizure should then, other circumstances not being unfavorable, dispose to a trial of home treatment. More particularly, the following forms are frequently of short duration, namely, those that result from alcohol, with the exception of the paralytic dementia produced by that agent; the milder attacks of mania that are apt to occur about the establishment of puberty in both sexes, especially in the female; the so-called metastatic forms occurring in rheumatic and gouty constitutions; the slighter seizures after childbirth and through over-lactation, though there is considerable uncertainty respecting both of them: in all these cases the medical attendant would be justified in advising that the effects of medicinal agents and other measures at home should be tested in the first instance. Patients suffering from mild types of melancholia are also frequently treated under the care of relatives; but the physician must never forget the tendency to suicide in such cases. Attacks of epileptic insanity likewise generally soon pass away, but then they not unfrequently recur in connection with fresh seizures; and, indeed, the mental state, even at its best, of epileptics who have reached this stage of their disease is commonly such that the asylum is the most suitable place for them. On the other hand, insanity of slow development, which has gradually attained a considerable degree of intensity, is not likely to be of short duration; typical general paralysis is an unmanageable as well as an incurable form; and varieties which present suicidal or homicidal features, or both, are dangerous; all these should be consigned to an asylum at once. Further, with respect to the class in which this extreme measure may have been at first delayed, should there be no improvement, and particularly should there be rather an aggravation of the symptoms after ten days or a fortnight of treatment at home, it will then in most cases be the wisest course to recommend removal to an asylum.

The following manuals may be consulted by the student: Blandford, Insanity and its Treatment, 3d edition, London, 1884.—Clouston (T. S), Clinical Lectures on Mental Diseases, London, 1883.—Savage (G. H.), Insanity and Allied Neuroses, London, 1884.—Sankey (W. H. O.), Lectures on Mental Diseases, 2d edition, London, 1884.—Spitzka, Insanity: its classification, diagnosis, and treatment, New York, 1883.

Those who wish to consult larger, and in some respects more comprehensive treatises, are referred to Bucknill and Tuke, Psychological Medicine, 4th edition, London, 1884.—Maudsley (H.), The Pathology of Mind, London, 1879.—Hammond (W. A.), Treatise on Insanity in its Medical Relations, London, 1883.

Some may wish to consult the writings of Pinel and his pupil Esquirol, who reformed asylum treatment in France, and laid the foundations of modern psychiatry: Pinel, Traité sur l'aliénation mentale, ou la manie, Paris, 1801.—Esquirol, Des maladies mentales, Paris, 1838.

Special treatises: Ireland, Idiocy and Imbecility, London, 1877.—Mickle, General Paralysis of the Insane, London, 1880.—Magnan, On Alcoholism: the various forms of alcoholic delirium and their treatment, translated by Dr. Greenfield, London, 1876.—Charcot, Lectures on Diseases of the Nervous System (Hysteria), translated for New Sydenham Society, 2 vols., London, 1877–81.—Laségue, Folie à deux (and other monographs), Etudes, tome i., Paris, 1884. —Briérre de Boismont, Des hallucinations, Paris, 1862.—Robertson (Alex.), Unilateral Hallucinations, Trans. Intern. Congress, vol. iii., London, 1881.—Hammond, Mysophobia (and other monographs), Neurological Contributions, New York, 1879-81.

CHAPTER IX.

DISORDERS OF THE RESPIRATORY AND CIRCULATORY SYSTEMS.

DYSPNŒA, difficulty in breathing, want of breath, pain in the chest, palpitation of the heart, cardiac spasm and anguish, a sense of impending suffocation, and all forms of rapid, labored, or obstructed breathing, require to be considered in one clinical group, as they frequently become inextricably mixed up together. They depend on the most diverse causes. Amongst these may be named nervous or spasmodic asthma; inflammatory affections of the larynx, trachea, lungs, bronchi, pleura, and pericardium; destructive lesions of the lung and perforation of the pleura with pneumothorax; inflammations or abscesses about the fauces, larynx, or œsophagus; various forms of cardiac disease; aneurismal and other thoracic tumors; thrombosis and embolism of the pulmonary artery; dropsy of the abdomen and of the pleura and pericardium; nearly all abdominal swellings and tumors when bulky; sometimes abdominal tumors which are not very large also give rise to dyspnœa, as in the case of the gravid uterus in the early stage of certain pregnancies; spasm of the glottis as an isolated affection (laryngismus stridulus), as well as an incident in other diseases; uræmic poisoning and other forms of defective renal activity; certain varieties of anæmia, chlorosis, and hysteria; and at times grave nervous affections involving the respiratory centres, nerves, and muscles.

DYSPNŒA, PALPITATION, THORACIC PAIN, ETC.

The subject of dyspnœa must be approached in various ways.

1. By trying to discover from the patient the character of his distress, and the causes of its aggravation on moving or breathing deeply for example, as noticed by himself.

2. By observing the number of respirations in a minute, the appearance of laborious breathing, the evidence of any stitch or sharp cutting pain, of acute suffering, or of mortal terror as depicted on his countenance: by noticing any ap-

pearance of cyanosis and lividity, or of pallor in the face; and by scrutinizing the sounds, whether crowing, hoarse, wheezing, gurgling, or choking, emitted during respiration. We must, likewise, notice the attitude assumed by the patient during an attack, and the character of the cough and expectoration when these are present. (See pp. 338, 348, 353.) Paroxysms of coughing from any cause may of themselves produce considerable dyspnœa, and frequently aggravate it when they are severe.

3. By an appreciation, whenever this is possible, of the previous facts or history of the case; particularly as to any known disease in the heart, or the thoracic aorta, the lungs, pleura, or pericardium, or anything likely to lead to perforation of the pleura (phthisis, abscess, etc.): any rheumatic attack likely to give rise to pericarditis or endocarditis; anything predisposing to thrombosis or embolism in the pulmonary artery (the puerperal state, venous thrombi, and dilated heart); any condition predisposing to rapid dropsy, especially into the pleura, pericardium, or pulmonary tissue (scarlatinal nephritis in particular); any known tendency to angina pectoris or spasmodic asthma in the individual or in his family; and any preliminary symptoms of diphtheria, croup, or laryngitis.

4. By a careful physical examination of the thoracic and other organs. By this we can often detect whether the air is prevented from entering the lungs by tumor, pressure, or spasm in the upper portions and larger divisions of the respiratory tract, or by the presence of fluid or air in the pleura, or by œdema and exudation into the small bronchi and air-vesicles, or by other forms of pulmonary or pleuritic disease. We can often also detect evidences of heart disease, pericarditis, or effusion, even although the distressed state of the patient is not favorable for a careful examination of the chest; dropsical accumulations or tumors in the abdomen pressing on the heart and lungs can be readily observed, and the state of the urine may throw much light on the case. An examination of the neck for any aneurism, tumor, or abscess, and of the throat for any abscess of the tonsils, or for one bulging behind the pharynx, for diphtheritic patches in the fauces, or for tenderness over the larynx, is of great importance. Laryngoscopic examination can seldom be practised in the height of an attack, but even then an examination by the finger may sometimes supply important information (see Chapter X.): on the partial subsidence of the attack we may

find evidence of thickening and ulceration of the cords, or tumors, œdema, or abscess, in this situation, giving rise to mechanical obstruction or recurring spasm; or we may find paralysis of one of the cords indicating rather the origin of the attacks in some irritation of the laryngeal nerves lower down. (Many of these subjects are dealt with in other sections of this book, as will be seen on consulting the index.)

The number of respirations per minute affords an important indication of dyspnœa. The normal rate may be stated as about 18 to 20 per minute in the male adult while awake, but variations of from 12 to 24 are not uncommon. In children, and also in women, the rate is somewhat more rapid. Like the pulse, it is much affected by different postures, and by sleep, agitation, exertion, speaking, coughing, and swallowing. The respiration is also apt to be deranged in its rhythm when the attention is directed to it, so that we must try to count its rate without the patient's noticing it. This may be done very well while taking the pulse, by continuing to hold the patient's wrist, while we watch the movements of the chest unknown to the patient, and count them for half a minute; or, if these are not very visible, we may lay the hand or a finger very lightly, and as if by accident, on the chest wall, under the clavicle in the female, and below the xiphoid in the male; in other cases we can count best by listening to the breathing, or by watching the movements of the bed-clothes. In critical estimations of the rate of breathing we watch for a quiet period, or take some opportunity of noting the number while the patient is sleeping, or at least before he is disturbed by speaking, coughing, moving, or crying; or we may require to let a little time elapse for the subsidence of these disturbances if they have already occurred.

In febrile states, from whatever cause, the respiration is often quickened, the increase keeping a certain proportion to that of the pulse; the ratio in health is 1 respiration to about 4 or 4.5 beats of the pulse, and so long as something like this ratio is maintained, the increase may be ascribed simply to the febrile disturbance affecting the system. When the rapidity of the respiration exceeds this proportion, we infer the existence of some respiratory disorder. An attack of bronchitis, for example, may reveal itself in this way in the course of typhus. The respiration is accelerated in almost every variety of disease of the respiratory organs, in acute or subacute forms, and this constitutes one of the features of nearly every kind of dyspnœa. The number is often 40 or 50, it sometimes rises to 60 or 80 per minute, and may almost equal the pulse-rate (1 respiration to 1.25 pulse-beat).

The respiration is somewhat rapid and easily accelerated in certain non-febrile states, even apart from any special respiratory complication; the debility after fever, and certain anæmic conditions, may be mentioned amongst these. In rickets, the rapid breathing seems to be due in part to the general state, and in part to the great liability of rickety children to pulmonary collapse.

The appearance of labor in breathing is of great importance.[1] There may be very rapid breathing without any great effort or labor, but the least additional strain may show at once that the breathing is being carried on at the extreme limit of the patient's power; any exertion, such as sitting up in bed, or speaking, or indeed anything which demands additional effort, brings out the patient's weakness in this respect; he says a word or two and stops to recover breath, and then resumes. A striking illustration of the same thing is found in infantile dyspnœa; the child's whole energy is required for breathing, and so after a momentary attempt at sucking, or after one or two such attempts, he refuses the breast, although obviously anxious to drink, and no doubt very thirsty; this refusal is an important clinical fact in the pneumonia and suffocative bronchitis of children. In uncomplicated pneumonia and some other diseases characterized by rapid breathing, no great effort is visible; the state of matters is very different in cases where an obstruction exists to the entrance of air through the glottis, trachea, or bronchi—whether this arises directly from organic obstruction or from nervous spasm. Hence in laryngeal obstructions and spasms from any cause, in croup, in spasmodic asthma, and in bronchitis and emphysema, the efforts at breathing often assume the most extraordinary intensity; the thoracic movements and the action of the accessory muscles of respiration may be exaggerated, the muscles of the neck stand out with great distinctness, the patient sits up or even stands, and sometimes clutches at objects with his hands, so as to give the muscles greater purchase. We have here a typical picture of *inspiratory dyspnœa*. The excessive action of the dilator narium is often a valuable index of this laborious breathing, especially in the case of children affected with pneumonia and bronchitis.

Similar results likewise happen when, instead of obstruction to the passage of the air, a large part of the breathing surface is suddenly cut off in other ways, as by the perforation of the pleura and the consequent collapse of the lung from pneumothorax, or by sudden effusion of fluid into the pleura, or even by sudden œdema, hemorrhagic condensation, or congestion of the lungs. Again, a similar result may be brought about by sudden blocking of the pulmonary artery—although the air may enter both lungs freely, the pulmonary function is, of course, arrested or impaired by such an obstruction. This element of *suddenness* is of great importance in leading to dyspnœa, for if the breathing surface be cut off gradually, the respiration and the system may have time to adapt themselves to the altered conditions; hence there may be extensive thrombosis of the pulmonary artery without any alarming dyspnœa, until perhaps a fatal displacement of some clot takes place; even pneumothorax may exist without the patient's being able to fix the probable date of its occurrence—the collapsed lung having, perhaps, been long practically useless from some previous extensive disease; the whole of one side and part of the other may be full of fluid, while the patient has scarcely been conscious of breathlessness, owing to the very gradual increase of the effusion. This element of suddenness exists, of course, in all the spasmodic forms of laryngeal and bronchial obstruction. A further point of importance in connection with dyspnœa is the exact situation at which the mechanical impediment exists; a slight œdema of the glottis may cause suffocation, and an exudation in the trachea or large bronchi gives rise to the most distressing dyspnœa from the large respiratory area involved.

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[1] See also remarks under "Nervous Dyspnœa," p. 347. Compare also p. 37.

But the patient with obvious dyspnœa may experience or manifest no difficulty in inspiration: his difficulty as felt by himself may be the emptying of his chest of the air. This *expiratory dyspnœa* as it is called may be attended by prolonged wheezing sounds with the expiratory act. This form of dyspnœa occurs in pulmonary vesicular emphysema and spasmodic asthma.

The following are the common causes of dyspnœa, arising, directly or indirectly, in a *mechanical* manner: Inflammations of the larynx, œdema and spasm of the glottis, foreign bodies in the larynx or trachea; diphtheritic or croupy membranes in the larynx, trachea, or bronchi; tumors and abscesses either of the larynx itself or pressing on it or on the trachea from without (especially aneurisms, cancers, retropharyngeal abscess); aneurisms, glands, or other tumors in the chest pressing on or irritating the recurrent laryngeal nerves; spasmodic or nervous asthma; inflammatory disease of the lungs, bronchi, and pleuræ; dropsical exudations into the pulmonary tissue or into the pleura; pneumothorax; extensive consolidation, collapse, or emphysema of the lung; extensive excavation from tubercular disease, bronchiectasis, gangrene, or abscess; embolism and thrombosis of the pulmonary artery; and pressure on the chest from below, from abdominal distention or tumors of any kind. (Compare next section.)

Cardiac dyspnœa, or cardiac asthma, as it is sometimes called, may be explained in certain cases, or to some extent, on mechanical principles. For example, a somewhat movable thrombus in the right side of the heart, at the tricuspid orifice, may play a similar part to that of a plug in the pulmonary artery, and ordinary forms of incompetency of the valves or of obstruction at the orifices may, if extreme, retard the circulation through the lungs, and so impair their function. Again, the lungs may be involved through the heart—pulmonary infarctions, bronchitis, congestion or œdema of the lung, and pleuritic effusion, may all have a cardiac origin, and be the result of mechanical impediments from plugs, diseased valves, etc. The great dyspnœa from exertion in heart disease may often be traced to increased strain on the circulation bringing into prominence mechanical defects too slight to be at other times of any great importance. But cardiac dyspnœa is often too extreme or too spasmodic and transitory to be readily explained on such mechanical grounds. Clinically, we must accept as a fact the frequent occurrence of the most extreme forms of cardiac and aneurismal dyspnœa, apart from any of the mechanical explanations or structural changes just suggested; the idea of some nervous cause is often forced on the mind.

Orthopnœa—the assumption of the upright posture for the purpose of getting breath—is one of the great features of cardiac dyspnœa. But in cases with effusion into the pleuræ, and even in œdema or congestion of the lung and bad bronchitis, the patient sometimes has a considerable tendency to sit up for breath. When, however, this symptom is strongly marked, we must always suspect the cardiac origin of the illness, or the presence of some cardiac complication; and this suspicion gains in strength if little or no pulmonary mischief be detected on examination. Thoracic aneurism is to be classed with cardiac disease in this respect. Affections of the pericardium, and adhesions of this membrane, likewise give rise frequently to orthopnœa, although simple rheumatic pericarditis even in an extreme form may exist without this symptom. All forms of cardiac disease—those involving the size of the heart, the tissue of the walls, the orifices, and the valvular structures—may give rise to orthopnœa. The cardiac element in the dyspnœa may, therefore, be a secondary or additional complication, appearing in the course of pulmonary emphysema, disease of the kidney, and other affections which tend to implicate the heart; and this cardiac complication may give rise to paroxysmal exacerbations in the midst of a chronic state of dyspnœa of moderate severity.

Occasionally the orthopnœa is so constant and so extreme that the patient cannot even lean back for a moment without the feeling of impending suffocation, and he can only get a little sleep while sitting up and leaning forward, with the head resting on his knees or hands, or on a table before him. Some patients, indeed, resolutely refuse to go to bed, and may sit in a chair for weeks and months together, without once even attempting to lie down. These extremely persistent forms of orthopnœa are usually associated with considerable dropsy.

The explanation of orthopnœa is plain enough when there is any considerable œdema of the lung, dropsy, or pleuritic effusion, as the recumbent posture tends in such cases to hamper the movements of the heart and lungs from the gravitation of the fluid. Further, the erect posture no doubt gives the respiratory muscles much better purchase in their play; but the extremely marked influence of posture observed in not a few cardiac cases cannot be reasonably explained in any such way, and appears to depend on some nervous cause.

Great increase of the dyspnœa on hurrying or climbing is closely related to orthopnœa in many respects. While found to some extent in nearly every form of disease which impairs the respiratory function, it is, like orthopnœa, specially marked in cardiac affections of all kinds. A patient who is able to walk fairly enough and at a moderately good pace on a level road, may at once show signs of dyspnœa if there be a continuous, although gentle ascent, or if a few steps have to be mounted briskly; hurrying and mental or emotional excitement operate in the same way; all of these influences often operate together against a patient in hurrying to a high-level railway station, and not unfrequently he first finds out his weak point under such circumstances.

Amongst other causes which operate in causing dyspnœa under similar circumstances may be mentioned all forms of disease impairing the functions of the lungs; conditions of debility, anæmia, etc., from whatever cause; disease of the kidneys, dropsy, obesity, pregnancy; and the changes incident to advancing age.

The importance of this feature in the diagnosis of cardiac disease is so great that we sometimes set our patients to go up one or two stairs, or even to run a few yards, when we are doubtful of there being any affection of the heart, so that we may judge of the state of their respiration at the end of such an experiment.

Palpitation is one of the accompaniments of the various cardiac symptoms just described; sometimes it forms the most prominent feature of such complaints, but it may exist quite apart from any organic affection of the heart.

When due to cardiac disease it has a tendency to very marked exacerbations in connection with exertion and excitement, so that when the palpitation occurs frequently, or chiefly, apart from these influences, and when it is not readily induced by running, or by climbing hills or stairs, we have good reason to hope that it is not due to organic disease.

The palpitation of cardiac disease is frequently associated with an undue heaving impulse, and there is usually clear evidence of enlargement or of valvular disease, on a physical examination of the chest. The right ventricle frequently becomes distended or displaced, so as to give rise to a painful sense of oppression and tenderness from the existence of pulsation in the epigastrium. The palpitation from aneurismal disease in the chest must be considered along with that of cardiac disease, and the investigations in both cases are conducted by similar methods; the palpitation and pulsations of aneurismal tumors must be carefully studied as to the site of their maximum intensity and diffusion. (See Chapter XVI., Part 2, "The Physical Examination of the Heart.")

Incipient inflammation of the pericardium and endocardium may readily give rise to this symptom, and palpitation of the heart may also be determined by pressure on or displacement of the heart resulting from pneumothorax, pleuritic effusion, etc.

But, apart from these organic affections, palpitation is very common in dyspepsia, and particularly in cases with much flatulent distention of the stomach. In such cases, especially when complicated with hysterical tendencies, palpitation may attain its most extreme degrees; and in these forms it frequently proves most troublesome when the patient is lying still in bed. The palpitation of dyspepsia is often complicated with intermission or irregularity in the heart's action, which, by exciting and alarming the patient is apt to increase the palpitation still further.

Palpitation is one of the leading symptoms of exophthalmic goitre: it is then associated with prominence of the eyeballs, and a certain fulness or enlargement of the thyroid gland; frequently there is also organic disease of the heart.

Palpitation of the heart is likewise found in cases of anæmia and general debility: loss of blood from bleeding piles and uterine discharges, for example, may give rise to symptoms sometimes erroneously construed as cardiac. Palpitation and epigastric pulsation in boys sometimes owe their origin to the practice of masturbation or other forms of disorder of this class.

Throbbing of the abdominal aorta is not uncommon in debilitated and nervous patients, and it may thus simulate aneurism in this situation, but a careful examination of the vessel reveals a general pulsation of the aorta without any enlargement or any true tumor of the artery. Throbbing of the arteries in the body generally may likewise be felt by patients; this may arise from a relaxed state of their vessels, apart from any very serious affection, although such generalized pulsation likewise occurs in cases of aortic incompetency.

Pain in the chest exists in a great many cases of dyspnœa, and sometimes constitutes the leading feature and cause of the respiratory distress; this is especially marked in cases of pleurisy and pericarditis during the stage of friction; the movements of the chest are actually hampered by the pain induced by the movements. Similar distress is sometimes occasioned by pleurodynia. The detection of friction sounds over the heart and lungs in such cases explains their nature. The pain or distress in dyspnœa may, on the other hand, arise simply from the extremely urgent need for breath which the patient experiences; when carried beyond a certain point, this becomes exquisitely painful. It is intensified by any coincident overdistention of the right ventricle or by palpitation or tumultuous action of the heart, or by irregularities or imperfections in the contraction. These irregularities are often quite discernible by the patient, and may depend not merely on affections of the organ itself, but on pressure on it or displacement of it in connection with pleuritic exudations, pneumothorax, thoracic and abdominal tumors, excessive dropsy, or even distention of the stomach and bowels in cases of flatulence. Many cases, of course, have a complex origin, as when the pain of a perforation in the pleura and the incipient pleuritis thus induced are complicated with the extremely painful dyspnœa resulting from the sudden suppression of a lung, and from the pressure on the heart and liver due to displacement of the mediastinum and diaphragm. The combination of cardiac, pericardial, or aneurismal pains with pleuritic stitch, and the association of these with the most extreme forms of dyspnœa resulting therefrom, and from œdema or consolidation of the lung, with extreme dropsy, give rise to a complex distress which we have too often to witness.

A certain simulation of some of these alarming states may arise in connection with flatulence; this may be associated with pain in the neighborhood of the heart, with great palpitation, and, especially, in hysterical cases, with dyspnœa and a sense of choking. Gouty, neuralgic, and intercostal pains, and various sensations referable to uterine irritation, may also occasionally simulate the attacks just mentioned, or even those included in the next paragraph.

Angina pectoris is a name reserved for pain obviously of cardiac origin and of a very special and alarming character; all forms of cardiac anguish, although not presenting the features of this complaint in its most typical form, have a certain resemblance to this peculiar suffering. "The subjects of angina pectoris report that it is a suffering as sharp as anything that can be conceived in the nature of pain, and that it includes, moreover, something which is beyond the nature of pain, a sense of dying." (Latham.) Others speak of a feeling of "constriction" of the thorax, of its being an inward pain, or of its resemblance in some way to suffocation. But the most typical angina may occur without the least impediment to the respiration, and the patient may feel that he can breathe quite freely. The pain is not always centred in the cardiac region, but it always tends to the left side of the chest. The most constant of all the features of true angina is an indescribable dread of immediate death, or perhaps, as has been said, "a *sense* of dissolution, not a fear of it." In the case of those who cannot express their feelings accurately, or who do not care to do so openly, we can sometimes detect in their countenances the evidence of a mortal terror. Along with the above there is often a transient pallor of the face, and likewise an associated pain shooting down the left arm, or darting across, as it were, from the heart to the elbow, or there may be numbness and tingling of the arm, spreading even to special fingers.

The most typical forms of angina pectoris may exist without any lesion recognizable during life; the dissections in fatal cases often show merely certain changes in the structure of the walls, especially fatty degeneration of the fibres, and atheroma of the coronary arteries: nearly every variety of disease in the heart or aorta may, at times, be found associated with this symptom and apparently giving rise to it: we may likewise say that indications of angina-like attacks may frequently be traced as forming an element in the complicated sufferings of heart disease.

The character of the noise heard during the breathless attack often guides us. The presence of snoring, or of very rough and loud-sounding respiration, is found in cases of tracheal obstruction (croup, diphtheria); the variation in the sound often suggests a gradually diminishing aperture for the passage of the air, resulting in a half-choked croak or squeak. Something of the same kind of breathing may sometimes be heard where an abscess behind the pharynx, or even in the tonsils, causes much dyspnœa. When the obstruction consists in a spasmodic closure of the glottis the sound is more crowing or stridulous (pertussis, laryngismus stridulus, irritation from foreign bodies, ulceration or tumor in the larynx, or pressure on the laryngeal nerves, etc.). If the constriction be further down in the trachea and larger bronchi, whether spasmodic or mechanical, the breathing may have more of a wheezing or whistling sound: if there be much fluid secretion there, gurgling sounds may be loudly heard. But some of the most severe forms of dyspnœa and gasping respiration may exist without noisy respiration, as in embolism of the pulmonary artery, pneumothorax, and rapid effusion into the pleura or pericardium. In cardiac and aneurismal dyspnœa, the presence of noisy respiration will depend on the nature of the pulmonary or laryngeal complications.

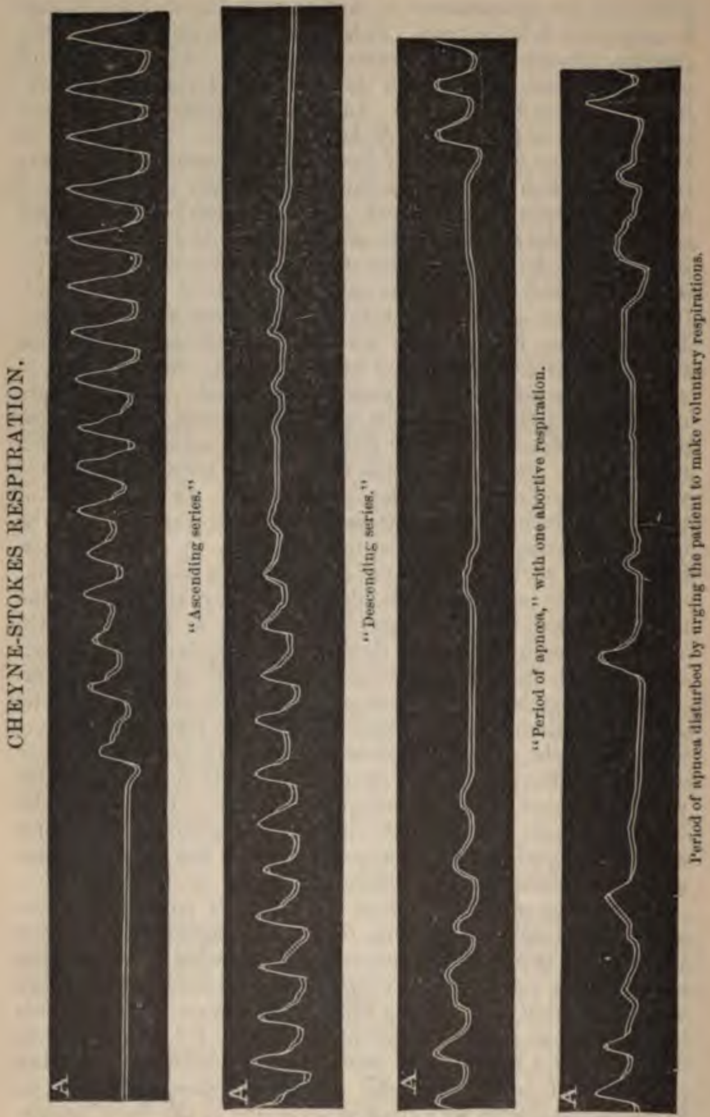
Lividity or duskiness of the face (cyanosis) is a feature in dyspnœa requiring careful attention; in extreme forms a similar condition can sometimes be recognized also in the fingers, nails, and other parts. All diseases or accidents interfering with the entrance of air to the lungs, or with the efficiency of the respiratory function, may produce cyanosis. A tinge of lividity can often be detected along with the febrile flush of pneumonia, of phthisis, and of acute tuberculosis, especially if these diseases be extensive. A certain degree of it is habitual in all serious forms of acute bronchitis; in this latter complaint, in children, the blue color of the face is an indication of considerable gravity. In attacks of bronchitis supervening on extensive emphysema, lividity is habitual, and often excessive. In extreme pleuritic effusion, likewise, lividity indicates the gravity of the condition. In extensive excavation or destruction of the lung, and also in pneumothorax, lividity is often very marked. In cardiac disease of nearly every form lividity is apt to appear, imparting a dusky flush to the cheeks from chronic passive congestion: this may be so habitual as to lead to changes in the tissues (induration and even inflammation). If the cardiac disease involves the tricuspid valve, more extreme lividity may take place. In malformations of the heart, and defects permitting the direct passage of blood from the right to the left side, extreme lividity usually exists; in infancy this may often be seen to come on during crying, or at certain times only, owing, probably, to the varying efficiency with which the fœtal orifices are closed. The term "morbus cæruleus" is applied to this condition. The most extreme cyanosis, however, may exist from such congenital causes without the least dyspnœa. Amongst other causes of lividity, not specially referred to in the above, may be mentioned cholera during the stage of collapse, and the inhalation of gases not adapted for respiration (nitrous oxide, chloroform vapor, carbonic acid, etc.).

Altered rhythm of the breathing; Cheyne-Stokes breathing; nervous and renal dyspnœa.—Alterations in the rhythm of the respirations sometimes occur. In health the breathing, although very regular on the whole, frequently presents an occasional inspiration of greater depth than usual, a fact of which we frequently avail ourselves in the auscultation of young children. But very marked alterations in the respiratory rhythm are found in certain cases of cardiac disease (especially dilated and fatty heart), and sometimes in cerebral affections, or even in certain fevers where cerebral symptoms supervene. The breathing referred to is sometimes named "suspirious" or "sighing," and in slight forms may consist of a few quick gasps, or deep sighing inspirations, followed by a period of slow and shallow respiration, or by a very temporary suspension of the process. This form of breathing may be associated with attacks of "angina sine dolore" (Gairdner), as manifested by the look of anguish and general distress depicted on the countenance of cardiac patients, without, it may be, any very definite pain. This suspirious respiration is often present, likewise, in very variable degrees, in some cases of cerebral disease, and also in the course of fevers where cerebral symptoms have arisen. In its most marked character it is spoken of as the *Cheyne-Stokes respiration.* "It consists in the occurrence of a series of inspirations increasing to a maximum, and then declining in force and length until a state of apparent apnœa is established. In this condition the patient may remain for such a length of time as to make his attendants believe that he is dead, when a low inspiration, followed by one more decided, marks the commencement of a new ascending and then descending series of inspirations." (Stokes.) This extreme form is met with in connection with various forms of cardiac disease—not merely in fatty degeneration, to which it was at one time specially ascribed. It also occurs in aneurismal disease, and in cases of scabrous aorta without aneurismal dilatation; very frequently the association is with renal disease and uræmic poisoning, but in such cases there is very often some cardiac complication also. In some cases of tubercular meningitis "Cheyne-Stokes respiration" may be found in perfection; the distinction drawn by some between the cerebral variety and that of cardiac origin seems untenable; the difference is rather in the degree of approximation to the type described, all gradations being found at times in both, although the rhythm is no doubt less "regular in its irregularity" in the so-called "cerebral breathing" of brain disease.

The change is usually more gradual in its character in the descending than in the ascending series of respiratory movements. In the period of apnœa we can often trace a slight or usually abortive effort at respiration. All these points are well illustrated in the tracings appended. (Fig. 48.) The last of the series shows that even in the period of profound apnœa the patient, when urged to do so, can execute spasmodic, irregular, and imperfect respiratory movements.

During the period of apnœa the patient's consciousness, or at least his intelligence, seems often to be partially and sometimes more completely obscured; the cessation of respiration is sometimes preceded by very slight moaning sounds, more slight than, but still having some resemblance to, the sounds often heard as a cardiac patient, distressed for want of sleep, drops off for a few seconds into an uneasy slumber. During the period of apnœa the pupil usually becomes contracted, as in sleep, and dilates with the first or second of the deep inspira-

FIG. 48.



CHEYNE-STOKES RESPIRATION.

"Ascending series."

"Descending series."

"Period of apnœa," with one abortive respiration.

Period of apnœa disturbed by urging the patient to make voluntary respirations.

Exact copy of portions of tracings taken by Dr. M'Vail, by means of his "spirograph," from a case of Cheyne-Stokes respiration.

tions of the ascending series. Sometimes rhythmical alternations in the pupil are also noticed with *each individual breath*—the pupil contracting with the expiration, and dilating with the inspiration. (See p. 173.)

Labored respiration constitutes a common feature in cerebral apoplexy, dating sometimes from the very beginning of the attack, in the severe forms associated with deep unconsciousness and stertor. It may appear in the course of a day or two in cases which begin in a less alarming way, although advancing toward death. This disturbance of the respiration is probably due in part to the direct affection of the pneumogastric and other nerves; when developed later in the case, the respiration becomes involved from the unconscious and paralyzed condition of the patient favoring an affection of the lung itself. In the unconscious period after convulsion fits, the same state of the breathing may be present.

Nervous Dyspnœa.—Nervous disturbance has been already alluded to as complicating various forms of dyspnœa. Thus, in diphtheria or croup, the mechanical obstruction is often gravely aggravated by nervous spasm, and this forms a complication in the alarming but usually transient attacks of catarrhal laryngitis; the irritation of foreign bodies in the larynx or trachea, and the pressure of aneurismal and other tumors in the chest often determines serious, or it may be fatal, spasms of the glottis. Even in cardiac cases the breathlessness seems at times to be at least in part of nervous origin.

In spasmodic asthma the sudden onset of dyspnœa in the midst of practically good health, the rapid development of the most extreme respiratory distress, the rapid and very complete way in which this may pass off, and the almost magical subsidence of the attacks, at times, under the influence of agents acting on the nervous system, all point to the nervous origin of the complaint: this has been plausibly ascribed to a spasm of the small bronchial tubes. The patients make extreme and at times frantic efforts to breathe; the chest is soon distended to its utmost capacity, so that further inspiratory efforts, although very visible in the labored action of the accessory muscles of respiration, can make but little extra expansion; indeed, the real difficulty seems rather to be in emptying the chest of the air already in it, and the prolonged wheezing with the expiration is usually much more marked than the similar sounds with inspiration. Hence this form of breathlessness is often classified as an "expiratory dyspnœa." As expectoration becomes established the spasm relaxes, and the attack may pass off as quickly as it came; or the inhalation of medicated fumes, dense enough almost to choke the attendants, may bring instantaneous relief to the asthmatic.

In other cases the determining influence in an asthmatic attack acting, no doubt, partly through the nervous system, seems to be from pollen, hay, or special forms of dust (such as ipecacuanha) which are obnoxious to special individuals.

Nervous dyspnœa, however, may occur in a marked form apart from any gross nervous lesion, and without any evidence of the respiratory or circulatory organs being diseased. Such attacks are found almost exclusively in women and are usually complicated with hysteria. Allied to this is the dyspnœa sometimes found in the earlier months of pregnancy, where no sufficient explanation of it can be afforded by the mere distention; indeed it may pass off as the abdomen becomes larger.

Renal dyspnœa may show itself as an early symptom of kidney disease, appearing readily on exertion; but a more extreme form of breathlessness, resembling an asthmatic attack, appears sometimes in affections of the kidney apart from œdema, cardiac complications, or other recognizable influences.

Before any negative conclusion can be arrived at warranting the diagnosis of nervous or renal dyspnœa, and before any diagnosis of one form of dyspnœa to the exclusion of others can be safely made, the most careful exploration of the respiratory and circulatory organs must be undertaken, and the features of the whole case must be viewed from various aspects and even perhaps watched for some time in its various phases. (See "Introductory Remarks," p. 333.)

COUGH.

Cough is a leading symptom in many diseases; it sometimes constitutes the chief complaint of the patient, but in other cases we have to inquire very particularly as to its presence. In all cases of dyspnœa and thoracic disease the indications afforded by its absence, or by its special characteristics when it is present, must be regarded as most important. Occasionally it is so slight, and the patient has become so much accustomed to it, that it is only when attention is specially directed to it that its existence is noticed; in such cases those who live with the patient can often give us more reliable information than the patient himself. Such slight forms of cough, occurring chiefly in the morning, often constitute one of the early symptoms of phthisis. Although a very constant indication of pulmonary affections, cough is occasionally absent even in serious and advanced disease of the lungs, so that mere absence of this symptom is no security for the soundness of these organs. We must also remember that pleurisy even with extensive effusion frequently occurs without this symptom.

In the investigation of cough we inquire if it seems dry or moist and what kind of expectoration, if any, is brought up; if the cough is loud and clanging, with barking or brassy sound; or if it is associated with hoarseness, or imperfection in the closure of the glottis; if there is a sense of constant irritation with the cough, or if the act of coughing seems to clear away some obstruction; if it comes in paroxysms, or if it is more persistent and regular in its occurrence; if it comes on at particular times, as on going to bed at night or getting up in the morning, or on passing into a colder atmosphere, or on exertion, or on speaking; if it is set up by any special posture, as by lying on the back, or on the one side as compared with the other, or with the head low; if it is habitual in winter, disappearing or getting much less in summer time; if it is associated with retching, or terminated by an act of vomiting; and if there is stridulous or crowing inspiration associated with it. The duration of the cough, the site and character of the attendant pain, if any, the presence of dyspnœa, the special character of the sputum, and the examination of the chest, constitute important points in the inquiry.

The presence of cough always suggests the existence of some kind of disease in the respiratory tract, but we know that a cough may be induced, apart from this, in a reflex manner. Thus aneurismal or glandular tumors in the mediastinum may produce spasmodic or paroxysmal attacks of coughing from pressure on the nerves; syringing the ears has been known to produce coughing, and probably certain forms of aural disease may likewise do so; in hysterical attacks, and in pregnancy, cough may be set up apart from any disease of the air passages; and certain forms of gastric irritation may likewise produce a reflex cough. But "stomach coughs" and any other forms of reflex cough are not to be too readily accepted; the most careful and repeated examination of the chest must first be made in all such cases.

In *pertussis* (whooping-cough) the violent cough is the chief fact; there is usually, however, more or less bronchial catarrh also, the signs of which can generally be found in the lungs, especially if we listen just before a paroxysm of coughing. This disease is rare above the age of puberty; it is infectious, and one attack usually protects the patient from a second, but a relapse after an interval of freedom for some weeks or months is not uncommon. These points are often important in the diagnosis. In the early stage the paroxysm of coughing is characterized by a rapid succession of expiratory acts, without much pause between them, so that the child's face rapidly becomes red; this peculiar cough coming in paroxysms may often be recognized as whooping-cough by an experienced ear even before the "whoop" becomes developed. This "whoop" is a long-drawn crowing sound, due to the inspiratory act which follows the violent series of coughs; this peculiar sound is produced by the passage of the air through a glottis partially closed by spasm. This sound may be loud and resounding, or it may be somewhat choked and scarcely audible or at times quite suppressed, through excess of the spasm. The child's face, by its blueness, or blackness, indicates the gravity of the last variety of fits ("dumb kinks"). To the violent paroxysmal acts of coughing the name "kinks" is applied by some mothers, the term "whooping" being reserved for the inspiratory "crowing." Certain cases pass through their course without a single paroxysm of "crowing" being heard, but this is quite exceptional. The paroxysm of whooping-cough is often terminated by vomiting, the contents of the stomach coming away freely; in many cases there is much glairy and sticky phlegm also, and this may be all that is brought up. The fits of coughing sometimes produce bleeding from the nose, ears, and eyes; great suffusion and much swelling of the eyes and face are common; and as a rarity, subcutaneous emphysema may be developed from rupture of the air vesicles through stress of coughing. All degrees of feverishness and prostration are found in whooping-cough, but these are usually present to a serious extent only in those cases associated with much catarrh, with diarrhœa, or other complications. In the slighter forms of the disease during the intervals of the paroxysms the child seems often perfectly well. In the diagnosis, the presence of an ulcer on the frenum linguæ is sometimes of considerable value; it appears in about one-half of the cases soon after the paroxysmal cough has been fully developed. It only occurs in those children who have incisor teeth in the lower jaw, and it seems to have a purely mechanical origin. This ulcer disappears with the diminution of the cough. The paroxysmal cough of pertussis, and also the ulcer, may both disappear with the advent of serious complications (pneumonia, convulsions, etc.) and may reappear after these have passed away.

A crowing inspiration, somewhat resembling that of pertussis, is found in young children in the disease known as *laryngismus stridulus;* it is due, as in whooping-cough, to spasm of the glottis, but there is not necessarily or usually any special cough in laryngismus. This "child crowing" affects rickety children in particular, and is frequently associated with attacks of general convulsions.

Another disease associated with paroxysmal cough and crowing is that known as *bronchial phthisis*, due to tubercular affections of the bronchial glands. This may bear a very close resemblance to pertussis. The history of a former attack of whooping-cough, or the absence of any evidence of infection received or transmitted, and the chronicity of the complaint frequently assist in the discrimination of this disease.

In *measles and influenza* the disease although of a general nature, falls specially on the organs of respiration, and manifests itself by cough among other symptoms. A certain degree of pulmonary catarrh or congestion, with more or less cough, is present in enteric fever and many other febrile diseases.

Irritation of the throat or glottis may set up a cough in a mechanical way. Thus the passage of fluids or solids toward the larynx may produce violent coughing, which tends to persist for some time, even after the source of irritation is removed. Greedy sucking on the part of a thirsty infant, the trickling down of fluids from the posterior nares (post-nasal catarrh, etc.), and the presence of an elongated uvula may be mentioned under this heading. Certain irritating gases, such as chlorine and sulphurous acid, if inhaled, likewise produce violent paroxysms of coughing in healthy persons. In those rendered specially susceptible, from disease in the larynx or bronchi, the passage from a hot to a cold atmosphere, or the reverse, may set up violent fits of coughing.

A laryngeal cough is often loud, clanging, and very frequent and irritating; it may also be hoarse and imperfect. Ulceration and thickening of the mucous membrane in the larynx may give rise to both forms; the ulceration is often associated with tubercular or syphilitic disease. Tumors, œdema, abscesses, etc., operate in the same way. Direct pressure on the trachea by an aneurismal or malignant tumor may give rise to a croupy quality of the cough, usually associated with stridulous respiration. A laryngeal cough may, however, arise indirectly from the pressure of a tumor on the recurrent laryngeal nerve. With this we may have evidence of laryngeal spasm, or of paralysis, or both. In paralytic affections of the larynx the cough, like the voice, is usually hoarse. All forms of laryngeal irritation are apt to give rise to spasm of the glottis. This often imparts a stridulous character to the inspiratory acts associated with the cough. In laryngeal ulceration streaks of blood are common in the sputum, but the expectoration is seldom profuse. An examination of the larynx by the laryngoscope (see Chapter X.); of the chest, for any signs of tubercular disease, aneurism, or thoracic tumor; and an inquiry as to the presence of constitutional syphilis, are all very important points in such cases. A barking, brassy cough is common in croup, and also in diphtheria involving the larynx and trachea. Along with this quality of the cough we have noisy breathing, which can usually be recognized at once as due to obstruction in the upper part of the air-passages. An examination of the fauces may reveal the white patches of diphtheritic exudation, the extension of which to the larynx has caused the obstruction, but in many cases of undoubted laryngeal diphtheria there may be no visible affection of the fauces. When the disease begins in the trachea there is usually a period of illness for a day or two days, associated with high fever, prior to the appearance of any alarming obstruction to the breathing. Very sudden attacks of hoarse, croupy cough, coming on in the night, and subsiding quickly on the use of warm baths, emetics, etc., are usually due to a form of laryngitis. (To this and also to laryngismus stridulus, the name "false croup" is sometimes applied.) Croup and laryngeal diphtheria cannot be separated clinically; a case of so-called croup, in its most typical form, may occur amidst, or may give rise to, undoubted diphtheria. Occasionally threads of membrane, or even hollow casts, are expectorated or coughed up in these affections.

Foreign bodies of the most diverse kinds sometimes pass into the trachea or into one of the bronchi: in the act of entering violent and paroxysmal cough is set up, but as this may gradually subside much doubt may remain as to whether the foreign body was swallowed, or whether it actually passed down into the trachea. In the latter case the cough usually continues to recur in paroxysms of varying intensity, and severe or fatal spasm of the glottis may supervene. In cases of this kind, assuming a chronic form, the cough may simulate that of advancing phthisis; and emaciation, sweating, and feverishness may all add to the resemblance; subsequent dilatation of the bronchi, the formation of cavity, and the secretion of pus may add further to the difficulties: when this takes place the fetor of the pus expectorated is often a striking feature. The discrimination may be impossible; but when the history clearly points to the accident in swallowing as the date of the appearance of the cough, when the family history is good, and the physical signs of phthisis equivocal in any way, the sputum fetid and destitute of the tubercle bacilli, the possibility of this form of disease, and the question of surgical exploration or interference must be considered.

In all varieties of *bronchial and pulmonary disease* cough is almost always present, sometimes in slight forms, sometimes in suffocative paroxysms of great severity. In the pneumonia of children, however, it is seldom present in the early stage, and in exceptional cases in adults it may be absent or at least trifling for several days after the acute signs of illness have appeared. In pericarditis cough is often a troublesome symptom; it has sometimes a hoarse quality. In pleurisy, apart from complications, there is sometimes an entire absence of cough; but pleurisy frequently accompanies pneumonia and phthisis; when cough coexists with pleurisy, it is often extremely painful—the pain being referred to the site of the pleuritic inflammation. In like manner, pain with the cough occurs notably in pericarditis and peritonitis, and also in rheumatic affections of the thoracic muscles. In bronchitis the pain associated with the cough is usually substernal A violent or very frequent cough often excites muscular pains, as the result of strain, all over the chest and abdomen; and it may, likewise, occasion distressing pain in the head. The character of the expectoration, the physical examination of the chest, and the previous history must be relied on in seeking to ascertain the cause of cough in pulmonary disease. It must be remembered that cardiac, aneurismal, or renal affections may constitute the primary disease of which the pulmonary mischief is but a manifestation or complication, and that some general diseases, notably pertussis, influenza, measles, and enteric fever may be the real cause of the pulmonary disorder and its attendant cough.

EXPECTORATION.

The expectoration of hospital patients is usually preserved for inspection as a matter of routine. Earthenware spittoons are generally employed, but glass dishes have the advantage of showing the character of the expectoration somewhat better, especially if it is abundant. In private practice we have to give special directions for the preservation of the sputa when this is a matter of importance, as in pneumonia and cases of hæmoptysis. Little vessels, such as soap dishes, or articles of a similar size, are generally at hand in the bedroom, and can be used for this purpose. When the quantity is large, we have sometimes to pour the contents slowly from one vessel to another, so as to judge of their character and admixture; or by emptying them on to a blackened plate we may be able to pick out little pieces for more critical examination. While thus emptying the contents, we are able to notice any fetor, or the peculiar odor of gangrene, if either be present. The sputum can often be best examined by floating some of it in water and teasing it out: small casts of minute tubules may thus be found. (For microscopic examination, see p. 359.)

We describe the expectoration as to its quantity in the twenty-four hours; as to its composition, whether mucous, purulent, mucopurulent, watery, serous, or bloody, as to its consistence, whether thick or thin, composed of separate and defined sputa, or more homogeneous; whether tenacious, viscid, fluid, or frothy. The frothiness may show itself as large air bubbles, or these may be so minute and so much mixed with the mucus as to require close examination. Various impurities are often mixed up with the expectoration—as blood from the gums, matters from the nose or stomach, pieces of food from the mouth, and accidental particles carried in from the air. Coloring materials suggestive of blood may be derived from the brown crust of bread, from wine, from tobacco-juice, and the coloring of sweetmeats.

In health a little mucus is expectorated, and in disease the sputum may consist chiefly of mucus. In smoky towns this is very apt to be of a dark color from the presence of floating soot; and in the case of miners, from similar causes, the expectoration is usually black. Occasionally the black color is derived from disintegration of the pulmonary pigment in cases with breaking up of the lungs, even in those who had long given up this kind of work.

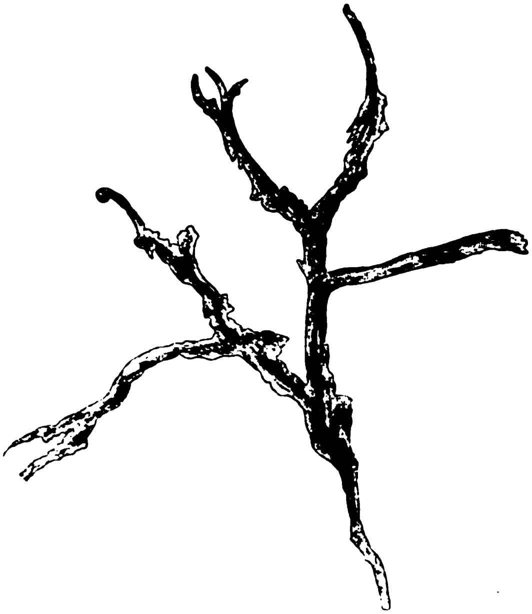
Frothy mucus, sometimes rather watery, is often expectorated in acute bronchitis and œdema of the lung. Minute aëration of the sputa is often found in the tenacious mucus expectorated in pneumonia, but this is usually rusty or distinctly bloody. (See p. 357.)

Purulent sputa cannot be absolutely separated from mucous sputa, as the two conditions merge into each other, and an intermediate condition is often named "mucopurulent." These forms of expectoration must also be described as to their frothiness, consistence, color, etc. The sputa may consist of almost pure pus; and when these spread out so as to form flat masses resembling the shape of pieces of money, they are called "nummular;" when they retain a spherical form they are termed "globular;" such sputa are usually dense and tend to sink in water. Both of these forms are commonly seen in cases of advanced phthisis, but nummular sputa may often be found in chronic bronchitis also. Purulent expectoration is common in all chronic forms of catarrh affecting the respiratory tract. Very profuse expectoration of pus, usually of a fetid character, may proceed from dilated bronchi (bronchiectasis). The influence of foreign bodies in causing excavation and profuse discharge of fetid pus must also be remembered. A sudden profuse expectoration of pus, or the sudden increase of it, may depend on the bursting of a tubercular vomica or of an intrapulmonary abscess, or it may be due to the opening of a collection of pus in the pleura into a bronchus, or to the opening of a hepatic abscess through the diaphragm; or, more rarely, to the bursting of some abscess in the mediastinum or elsewhere. When an empyema bursts in this way the pus expectorated is usually rather fluid, and it may come up in large quantities. The signs of pyopneumothorax usually become developed after such an accident, but this is not always the case. The pus from a pulmonary abscess may or may not be fetid; possibly it may have a gangrenous odor; its quantity on any one day although large is not excessive (say 12–18 oz.), and the microscope may reveal shreds of lung tissue in great abundance, and in some cases blood crystals are also present; such abscesses are sometimes due to embolism of the pulmonary artery. Hepatic abscess usually declares its presence by symptoms and facts pointing to the liver before it gets the length of perforating the lung.

Membranous shreds from the larynx and trachea are sometimes expectorated in croup and diphtheria, and *fibrinous casts* of the bronchi may occur in connection with plastic or fibrinous bronchitis. The dichotomous divisions are well shown in the drawing here given, which is a full-size copy of the specimen (Fig. 49.) Small casts of the minute tubes are sometimes found on floating out the sputum in water, or on microscopic examination. Spirals from the alveoli have been described by Curschmann as microscopic objects.

Little *cheesy masses* sometimes come from pits in the tonsils; but these, and also *calcareous masses*, may be expectorated in cases of old standing phthisis. They sometimes come from bronchial glands which have ulcerated into the tubes. *Shreds of hydatids* may be brought up in connection with the bursting of hydatid cysts of the lung and even of the liver. (See Fig. 72, Chapter XII.)

FIG. 49.



Fibrinous cast of bronchi; drawn full size, but the cast was slightly shrunken by keeping. (Dr John Wilson.)

The expectoration of blood (hæmoptysis) is always a most important fact. Care must be taken to avoid errors from the presence of coloring matter accidentally mixed with the sputum; the microscope may here be called in to discriminate the red blood-corpuscles. But even when we are sure of the presence of blood, this may possibly come from spongy gums, as many gums bleed very readily, especially if they are sucked; or the blood may come from the nose, trickling down the posterior nares, even when none appears from the nostrils; or the blood may come from ulcerations, etc., in the throat or in the larynx. The mention of these sources may serve to direct our attention in scrutinizing the source of the bleeding; examination by the laryngoscope is often important in this inquiry. Or, again, especially in profuse bleeding, there may be a question as to whether it may not come from the stomach. (See "Hæmatemesis.") Blood from the lungs is usually more florid and more frothy than that brought up from the stomach; the latter is usually dark and acid, and may be mixed up with partially digested food. The term "vomiting" of blood, as used popularly, signifies the bringing up of any large quantity of blood, whether from the lungs or stomach. Even when it comes from the lungs, the action resembles very much that of vomiting. Difficulties in the diagnosis may arise from blood from the lungs being in part swallowed before it is vomited up again. The continuance of blood-stained sputa for some hours at least after a profuse discharge of blood from the lungs usually affords guidance in doubtful cases of hæmoptysis.

When the blood really comes from the lungs, whether it be in large or small quantity, it is always a serious fact. The least grave form, perhaps, is the presence of slight streaks in the expectoration in connection with violent fits of coughing, or during an attack of moderately acute bronchitis.

The rusty sputa found in pneumonia owe their color to blood; in some cases the presence of blood is very pronounced in this disease. The rusty color is produced by the very intimate admixture of blood with the mucus, and this secretion is usually very tenacious, as can be shown by turning the vessel upside down; minute air-bubbles may often be seen in this expectoration. This rusty expectoration is very important in the diagnosis of pneumonia from pleurisy and other affections, although it is occasionally absent—notably in the case of children, and also usually in the pneumonic consolidations of typhus. Very bloody expectoration in pneumonic attacks, and the long-continued presence of blood in the sputa in such cases are always calculated to give rise to fears of phthisical disease.

Closely allied to the rusty spit of pneumonia, although often more distinctly bloody and more largely aërated, is that of valvular heart disease, or that which is found in minute aneurismal hemorrhages into the trachea, or that of pulmonary infarctions due to embolism of the pulmonary artery. This last form arises in cases of heart disease, and also in diseases characterized by a tendency to venous thrombosis (phlegmasia dolens, childbirth, etc.). The coexistence of pleuritic friction with evidence of pulmonary consolidation and hæmoptysis has often been noticed in cases of this kind.

An intimate admixture of blood with the sputum may give rise to a darker color, somewhat resembling prune juice; this occurs in cases where the blood lingers longer in the pulmonary tissues; it is found in cases of chronic pneumonia going on to destruction of the lung, and also in certain cases of aneurismal hemorrhage, where the openings are so minute as to leak only to a slight extent. In the destruction of the lung from gangrene there may be admixture of blood with the gray, greenish gangrenous expectoration, seldom to any very great extent; gangrene of the lung in children seems to be more frequently characterized by hæmoptysis.

A form of bloody spit, somewhat resembling the appearance of red currant jelly, is sometimes seen and is regarded as characteristic of malignant growths in the lungs.

Hemorrhage from the lungs may occur as part of a general hemorrhagic tendency as in purpura and hemorrhagic smallpox; the exact appearance of the blood will vary according to the extent and situation of the special bleeding. In certain cases of irregular or suppressed menstruation the discharge is said to find its escape occasionally from the lungs. This idea of "vicarious menstruation" must always, however, be regarded with the gravest suspicion, especially in young subjects, as suppressed menstruation and hæmoptysis afford strong grounds for suspecting pulmonary phthisis; this doubt can only be set aside by careful watching over a lengthened period.

Large hemorrhages from the lungs occur in phthisis both in its earliest and its latest stages; in cardiac affections, especially in disease of the mitral orifice and valve; and in cases of thoracic aneurism bursting into the trachea or bronchi. With regard to phthisis the profuse hemorrhage in the early stage is not always easily explained; it may occur while as yet there are no physical signs of consolidation, and sometimes there is even an absence of the physical signs we would expect from the presence of blood in the air vesicles: usually, however, some moist râles can be heard. (A slight hæmoptysis frequently repeated is much commoner, of course, in phthisis than these alarming attacks.) Large hemorrhages in the late stages of phthisis are usually due to the giving way of some considerable artery, destroyed probably in the course of the ulcerative process. Sometimes these hemorrhages are due to the rupture of aneurisms of the pulmonary artery; such aneurisms form on the walls of old phthisical cavities, and frequently give rise to smart hemorrhages, or to constant staining of the sputa for some time before the fatal hæmoptysis occurs.

Hæmoptysis may, as a rule, be ascribed to heart disease when valvular disease is discovered, apart from any signs of aortic aneurism. The large hemorrhages from rupture of aortic aneurism are usually almost immediately fatal, but the patient may rally for a time. Such hemorrhage is generally preceded by slighter forms of bleeding, but sometimes a profuse hæmoptysis is the first indication of aneurismal disease.

Microscopic Examination of the Sputum has assumed of late years a special importance in the diagnosis of phthisis from the detection of microörganisms. *Tubercle bacilli* are found in the sputum in a very large proportion of phthisical cases if adequate search be made by competent observers; as they may occur early in the case, when physical signs are indistinct, absent, or perhaps doubtful in character, their diagnostic importance is sometimes very great, inasmuch as they seem never to be found in the sputum of non-tubercular patients, even although they may be lying beside phthisical cases. Their abundance is, however, subject to great variation; one preparation from a given sample of sputum may contain many bacilli and another, from the same specimen, few or none; they are usually most abundant in the dense purulent portions; they may vary in the samples as collected in the morning or during the day, being usually most abundant in the former; they may also vary much from day to day in the same case, no doubt from the variations going on in the process of destruction in the lung. On these accounts the individual specimen of sputum ought to have several preparations made from it; examinations of the morning sputum, on several separate days, ought also to be made before the least weight can be attached to negative results; even then the importance attached to the *absence* of bacilli is but slight, although in experienced hands negative results acquire value by their repetition. On the other hand, the detection of bacilli even once is of great importance, although here also repetition of the test is desirable, especially if the bacilli are few, in case of any error in observation.

The methods of detecting these organisms are now taught in the pathological laboratories, and it is desirable that some experience should be gained in this way before the method is applied to diagnosis. In the case of the tubercle bacilli the appearances alone are not sufficient, but along with the staining reactions they are regarded as conclusive apart from cultivation experiments.

Method of Ehrlich and Gibbes.—A double staining is used—fuchsine and methylene blue. A minute portion selected from a dense part of the morning sputum is placed on a cover glass and spread out very thin, say by rubbing it with another cover glass. This is then dried either by exposure to the air for a time, or by passing it lightly over the flame of a spirit-lamp. The glass with the dried film is now immersed or floated in the solution of fuchsine;[1] this may be put into a watch-glass, and separate glasses should be used for each specimen; the film of sputum should, of course, be directed down if the glass is floated on the solution; it should be left in contact with the coloring matter for half an hour. This process stains *all* the microörganisms of a reddish color. The next process is to remove the color from them all except the tubercle bacillus; this is done by dipping the glass with the stained film into dilute nitric acid (1 of strong nitric acid to 2 of water; some use these more dilute): washing in this for a few seconds removes the color: the acid is then washed off by means of distilled water. Methylene blue staining is next applied by dipping the glass for a few minutes into a saturated solution of this coloring matter; this colors all the organisms and matters blue except the tubercle bacilli: these may thus be found as minute rods colored red in the midst of blue surroundings.

For the examination a high power of the microscope is required, 300 or 400 diameters. An Abbe's condenser is useful; by it colored particles only are brought into prominence, and so the search is much facilitated. Sometimes minute fatty crystals may resemble the bacilli in color, but seldom very closely in form; any other organisms which retain the red stain differ in their general appearance.

The numbers found vary enormously, but little stress can be laid on this variation. The occurrence of very large numbers of bacilli in specimen after specimen, as examined on several occasions, seems to warrant a grave prognosis, and their very scanty or unfrequent occurrence may, more doubtfully, be held as a favorable indication, with the reserve already expressed regarding the natural tendency to variation in this respect.

Other specific organisms have been described, as the "pneumococci," and the micrococci of diphtheria, but as yet this part of the subject is too doubtful to be of use in regular clinical work, although deserving of investigation.

Fungous growths are often met with in sputum: they have as yet no special importance in diagnosis; but it is important to be familiar with them to prevent mistaking them for elastic fibres. Bacteria of ordinary putrefaction are also found in sputum.

Parasites.—Hooklets and other traces of hydatid cysts may be found in the sputum.

Epithelium: Spirals, etc.—The microscopic examination reveals pus and other forms of inflammatory corpuscles, but these have seldom much importance in the diagnosis. Abundant epithelial cells, when of columnar form, indicate implication of the tubes, whereas squamous epithelium has but little significance. Spiral bands of minute size are described by Curschmann as occurring in asthmatic cases; they have been supposed to point to inflammation of the alveoli. Casts of the minute tubules can sometimes be recognized microscopically.

Crystalline forms in the sputum are found in connection with hemorrhagic affections; blood crystals may thus occur in infarctions and abscesses. "Charcot's crystals" are of pointed octahedral shape and destitute of color; their significance is still obscure.

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[1] 5 c.cm. of aniline oil; 100 c.cm. of distilled water; filter this, and add 11 c.cm. of a saturated alcoholic solution of fuchsine.

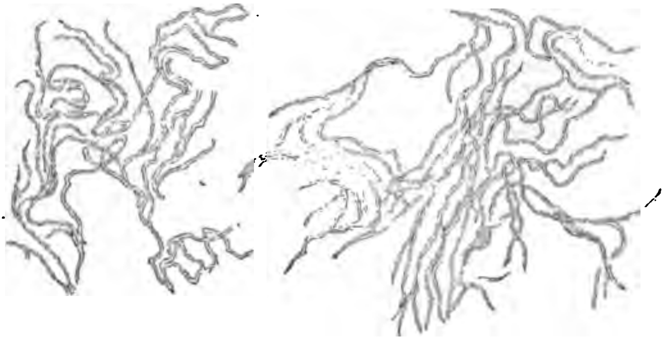
Cholesterine is rarely present in sputum: it occurs in connection with old accumulations of blood in the lungs, and has been known also to come from a communication with old pleuritic effusions containing similar crystals.

Fatty acids are developed in the fetid accumulations occurring in bronchiectasis. Leucin and tyrosin have also been noted.

Cancerous growths may occasionally be traced in the sputum, particularly in cases where the larynx is involved.

Lung tissue: Elastic fibres.—Of great importance in the microscopic examination is the detection of lung tissue or elastic fibres. When the shape of the pulmonary alveoli in these fragments can be recognized, we infer with certainty some destructive lesion in the lung, but not necessarily of the phthisical type. When fragments of yellow elastic fibrous tissue are found these come most commonly from the lung, but they may also come from the larynx. Abscess of the lung, from pulmonary infarction, may give rise to a purulent expectoration very rich in lung tissue, and a single microscopic field may contain many fragments of lung tissue in such cases. Elastic fibres from the lung may also be found in the sputum from cases of bronchiectasis, but the commonest cause of their presence is ordinary phthisis. When the lung tissue is abundant in the sputum, a little of it, placed on a slide, is all that is required for the examination; those skilled in the process may be able to pick out little fragments likely to contain pulmonary fibres, but the crowd of pus cells greatly impedes the examination. A few drops of caustic soda solution applied to the specimen may clear the field and facilitate the search.

FIG. 50.



Elastic fibres of lung tissue obtained from sputa after digestion in caustic soda.
(Drawn by Dr. John Wilson.)

Another method, recommended by Dr. Fenwick, consists in liquefying the pus by means of caustic soda. A solution containing about twenty grains to the ounce is added in equal volume to the expectorated matter brought up during a night; this is cautiously boiled in a flask or flat dish, so as to allow of efficient stirring and mixing; the mixture is just boiled, and if still not sufficiently liquefied, a little more of the solution should be added. Prolonged boiling and too much alkali tend to dissolve the fibrous tissue searched for, and so must be avoided. The liquefied mixture is placed in a cylindrical glass vessel, and after it settles, a few drops of the sediment may be examined with the microscope, or a portion of the liquefied material may be placed in a similar vessel, and three or four volumes of water added to it so as to assist the precipitation of the pulmonary fragments.

In examining the sediment, a few drops should be lifted by means of a dipping tube (not drawn to a point), and these should be placed on a large slide or shallow cell; the layer of fluid must, however, be very thin. A low power should be used—an inch or half-inch objective—and if any group of fibres resembling the arrangement of the pulmonary cells can be seen, higher powers may be used to resolve their structure. Separate yellow elastic fibres can often be recognized, with their typical curling at the ends. The pieces vary much in size; sometimes only a few loose fibres can be found. (See Fig. 50.)

Several things tend to confuse the beginner in this inquiry. Portions of vegetable tissue, from the food or from accidental admixture, are often found, as they resist, of course, the caustic action of the soda; their cellular structure sometimes misleads. More misleading still is the appearance of certain vegetable growths; but their branching and interlacing fibres usually guard us from error. A good plan for the beginner is to secure some pus from a phthisical cavity, at a post-mortem inspection, and by subjecting this to microscopic examination after digestion in soda, and also without any such preparation, he becomes familiar with the appearances searched for, apart from most of the structures which tend to confuse.

FLUIDS REMOVED FROM THE CHEST BY TAPPING.

These have considerable significance in the diagnosis and prognosis of certain cases. The most important point is, whether the fluid is purulent or serous. This can usually be judged of pretty accurately by the eye, on the first few drachms being seen in the tube. Occasionally a pretty clear fluid becomes almost solid after its removal; more commonly a certain amount of coagulation, varying much in extent, can be recognized, but frequently almost no trace of coagulation is perceptible. The highly coagulable fluid indicates the presence of a certain intensity of the inflammatory process.

Admixture with blood renders the fluid less clear, and in many cases forms a transition stage toward purulent transformation not always easy of recognition. In such cases we may find a slight deposit of cells resembling pus, with blood above it.

Slight admixture with blood is sometimes ascribed to the puncture of the chest wall, but is usually due to the bloody character of the fluid itself. Sometimes after repeated tappings, the reddish color changes to a more chocolate tint.

Very bloody fluid is always suggestive of a bad type of pleuritic exudation. Most of such cases prove to be due to malignant disease. Sometimes, however, the bloody fluid arises from tubercular disease of the pleura.

Purulent fluid suggests, of course, a very different diagnosis and prognosis from clear serous fluid. The most important distinction in purulent fluids is between those which are fetid and those which are not.

In the further examination of the fluid removed, especially when clear, we note the reaction, the specific gravity, and whether it is, as is usually the case, loaded with albumen. The microscopic examination often reveals blood, leucocytes, or pus corpuscles; these may be fatty; compound granular corpuscles are also common. Sometimes we find cells suggestive of cancerous growths. Occasionally crystals of cholesterine or blood crystals may be found in the case of old effusions. Hooklets or other indications of parasitic cysts are sometimes present, although such cases are rare in this country. (See Fig. 72.)

HEMORRHAGES.

In the investigation of a case of anæmia, and in conducting certain parts of other inquiries, we have sometimes to ask about the occurrence of any serious loss of blood. Such losses may be serious from their immediate severity, or from their long continuance. It is often necessary to enumerate to the patient the various forms of hemorrhage when making the inquiry at him, as otherwise we may fail in ascertaining the facts. Thus we inquire for any excessive bleeding occurring from the surface, from wounds, ulcers, leech bites, etc. In the case of women, we ask about any losses of blood in connection with abortions, or with childbirth; and for any other hemorrhages from the womb (menorrhagia, metrorrhagia). Spitting or vomiting of blood, whether from the lungs or stomach (hæmoptysis and hæmatemesis), and bleeding from the nose (epistaxis), or from the gums, can scarcely be overlooked. Passing blood from the bowels, and the bleeding from piles, should be inquired for *separately*, to prevent mistakes, and the change of color in the blood, giving rise to dark or tarry motions (melæna), should be explained to the patient. Blood in the urine (hæmaturia) is usually recognized as such by the patient, if very profuse and long continued, but smaller quantities may escape notice; subcutaneous hemorrhages or blotches, and purple spots may also be inquired for.

Most of these forms of bleeding are discussed under their special sections, but bleeding from the nose (epistaxis) requires some special notice here. Like other forms of bleeding, it may be due to general causes, such as purpura, etc. (see p. 140), this form of hemorrhage being but one of the manifestations.

Epistaxis also occurs in connection with severe headache, arising either from functional disturbance or from cerebral disease. The hemorrhage is followed sometimes by considerable relief; it may be brought on in some persons very readily by excitement and heated rooms. In children a bleeding from the nose often occurs without obvious cause and without any serious significance. It is not uncommon in the early stage of enteric fever, and it also forms an early symptom in certain cases of cardiac, splenic, and hepatic disease of various kinds. It occurs sometimes also in renal affections. Bleeding at the nose often arises in direct connection with the violent paroxysms of whooping cough, and it may be associated in this disease with bleeding from the eyes and ears. Sometimes, although rarely, this bleeding from the nose is so readily excited by the fits of coughing, and is so excessive, that we must suppose some peculiarity in the system at the time, especially as this proclivity, after lasting for a while, may pass away, although the fits of coughing continue, or even become more violent. Bleeding from the nose may be from one nostril only, or from both. In many cases the blood goes back to the throat, and it may be swallowed or brought up according to the strength or the position of the patient. Slight bleeding from the nose is often due to picking the nostril. This occurs in children chiefly, and is suggestive of gastro-intestinal irritation from worms, diarrhœa, etc.

Amongst the general causes of hemorrhage, applying to many or most of the forms, may be mentioned purpura hæmorrhagica, the hemorrhagic diathesis, and hemorrhagic smallpox. Bleeding at the nose often arises in enteric fever, probably from general causes; intestinal hemorrhage is mostly due to the local affection in this disease. In relapsing fever, menorrhagia and post-partum hemorrhage are common; and floodings after abortions or parturition are sometimes most alarming in typhus fever and smallpox. Scurvy resembles purpura in predisposing strongly to hemorrhage from the gums and other mucous surfaces, and also from the ulcers which arise in its course.

The hemorrhagic diathesis (hæmophilia) must also be mentioned here. The bleedings connected with this state may be spontaneous—apart from any obvious injury—but more commonly they arise from slight wounds, knocks, or pricks; leech bites are peculiarly apt to be intractable. Affections of the joints sometimes appear in young subjects in connection with this state. The joint affections seem sometimes to be due to injury, probably from effused blood.

The hemorrhages from chronic hepatic, cardiac, and renal disease are usually determined by local conditions—cardiac disease giving rise especially to hæmoptysis, hepatic disease to gastric, intestinal, or hemorrhoidal bleeding, and renal disease to hæmaturia—but a general influence can also be traced in all, from their tendency to be associated with small subcutaneous hemorrhages and epistaxis. Hemorrhage under the conjunctiva occurs at times in renal disease, and retinal hemorrhage is a well-known complication. Cerebral hemorrhage is likewise common in renal disease, especially when associated with cardiac hypertrophy.

In the forms of splenic enlargement due to malarial fevers and other causes, in the different varieties of leukæmia and lymphatic disease, and in pernicious anæmia, epistaxis and subcutaneous hemorrhages also occur.

EXAMINATION OF THE BLOOD.

Apart from the superficial examination of the blood lost in hemorrhages of various kinds, much might be hoped from an elaborate chemical and microscopic investigation of samples of the blood in different forms of disease. Hitherto comparatively little has been made of this form of inquiry, but indications of its growing importance are not wanting. With regard to the chemical department of this subject there are two great difficulties. We have to face all the complications of one of the most difficult departments of organic analysis, while but few physicians in actual practice, if, indeed, there be any, are adequately prepared suddenly to undertake such investigations when an important occasion happens to arise. The works of Hoppe-Seyler may be referred to for the best instructions in this branch of chemistry. But further, we are confronted with the practical difficulty of obtaining samples of blood at such times and in such quantities as chemical analysis demands: the abandonment of venesection as a common form of treatment renders this scarcely possible. While this practice was common, attention was much directed to the presence or absence of the "buffy coat" in the blood withdrawn, an appearance so usual in inflammatory diseases that its presence was relied on, in doubtful cases, as an indication of the existence of inflammation.

Occasionally, even now, we try to procure small quantities of blood for experimental or diagnostic purposes, as described in the section on gouty joints where Garrod's method of detecting uric acid is dealt with in detail (p. 152).

Minute quantities of blood for microscopic and other similar examinations are always obtainable, without detriment to the treatment, of whatever kind this may be: fortunately it is in this direction that the most distinct advances have recently been made in the examination of the blood for the purposes of diagnosis.

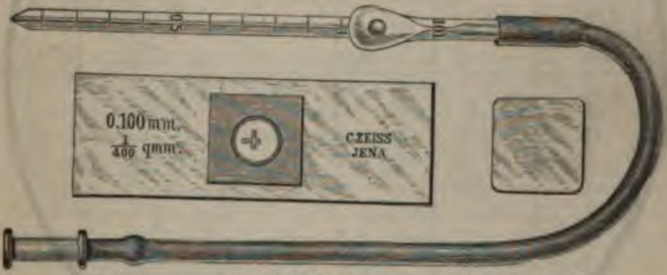
The richness of the blood in hæmoglobin may be estimated in various ways. One of the simplest is by Dr. Gowers's hæmoglobinometer. A definite quantity of blood is diluted with water in a graduated tube till it comes to the standard furnished by another tube colored for this purpose. This standard is so arranged that normal blood should bear dilution up to 100 volumes. A capillary pipette is used to measure 20 cubic millimetres of blood drawn from the finger by the prick of a small lancet: the wound should furnish enough of blood without any squeezing being required. The blood is blown into the empty tube, or rather into a few drops of water placed at the bottom of the tube to prevent coagulation, and then shaken up quickly with the water: water is then cautiously added by means of a suitable pipette: this is done with occasional shaking till the eye recognizes that the standard tint has been reached. This should be judged of by holding both tubes up to the light and also by looking down on them as placed against a white object. If we find 100 degrees of dilution are required, we reckon it to have the normal or average color: if 110 are required, we reckon it 10 per cent. richer than the average: if 50 degrees of dilution suffice to bring the blood to the standard tint, it has only one half of the normal color: or it may fall to 20 degrees, indicating, of course, only 20 per cent. of color.

The richness of the blood in corpuscles might be supposed to be deducible from the color test, inasmuch as the red corpuscles supply the color. If, indeed, the red corpuscles are reduced by a half, we may be sure that the color test for the hæmoglobin will also give a great reduction. But it is found in disease that the red corpuscles may approximate to their usual number, and yet that the color of the blood is gravely deteriorated. Or, with a notable diminution in the number of corpuscles in a given volume of blood, there may be a still more notable diminution of the color or hæmoglobin. In such cases the inference is plain—each individual corpuscle is itself deficient in coloring matter.

In some forms of anæmia the corpuscular richness is much more notably diminished than in others: in chlorosis, for example, we may have a great diminution of hæmoglobin as shown by the color test, and but little reduction of the number of corpuscles. In pernicious anæmia we may have enormous reductions of the corpuscles, which sometimes only amount to about one-tenth of their normal number, and in this disease we may also find evidence of deficient hæmoglobin for each corpuscle.

Various instruments have been devised for counting the actual number of corpuscles in a given volume of blood. They are all somewhat similar. A capillary pipette is required for measuring a minute quantity of blood, and we require arrangements for diluting with a given volume of fluid: we select a 10 per cent. solution of sulphate of soda or some such fluid which will not destroy the corpuscles. The diagram (Fig. 51) shows "Potain's mélangeur" graduated to give 100 dilutions when the blood is sucked up to 1 and the fluid drawn up to 101 as marked below and above the bulb respectively: the bulb contains a glass bead to facilitate the shaking up and mixing. This is reckoned the best method of diluting and mixing, whichever instrument may be used for the counting. The figure here given (Fig. 51) shows the slide made for this purpose by Zeiss, of Jena. It consists of a cell $\frac{1}{10}$ of a millimetre in depth, and it is ruled with a great number of squares each of which is $\frac{1}{400}$ of a square millimetre. These small squares are arranged within a large square (containing sixteen of the small squares) ruled off with three lines so as to guide the eye in counting the corpuscles, as otherwise the strain on the eye is apt to be too great. (See Fig. 52.)

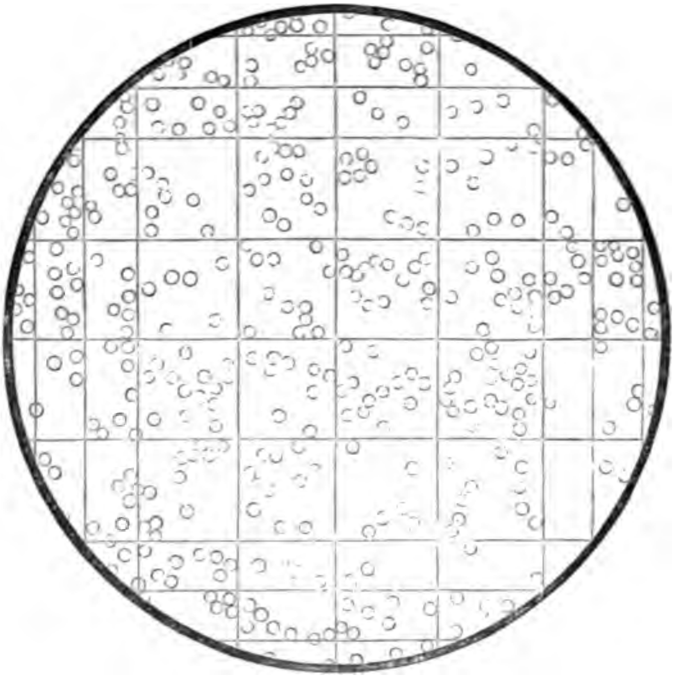
FIG. 51.



Potain's mélangeur and Zeiss' slide for counting the blood corpuscles.

If, then, a small drop of the properly diluted blood be placed in the centre of the cell, the edges of which are, of course, properly ground, and if a perfectly flat cover glass supplied for the purpose be now applied, we have the means of counting the corpuscles in a given volume of blood; for we know the depth of the cell, $\frac{1}{10}$ of a millimetre, and we know the superficies of the square, $\frac{1}{400}$ of a millimetre, and we know the dilution of the blood, $\frac{1}{100}$. Of course we require to count the corpuscles in a considerable number of squares in order to secure a fair average, 32 or 48 of the small squares, that is, 2 or 3 of the large ones. Having done so, we calculate what is the mean number for 4 small squares, and that gives the number in $\frac{1}{100}$ of a square millimetre. We multiply, therefore, by 100 for this, and by 10 for the depth of the cell; and again by 100 for the dilution of the blood; thus in Fig. 52 the mean number of corpuscles in 4 little squares is about 44:

FIG. 52.



Zeiss's slide, as seen under the microscope, with a drop of diluted blood. The series of sixteen small squares is ruled off by three close lines to give one large square: several of these squares are contained in the slide. (Drawn by Dr. John Wilson.)

$$44 \times 100 \times 10 \times 100 = 4,400,000 \text{ corpuscles}$$

in one cubic millimetre of blood.

In order to estimate the significance of this figure, we require to know the numbers obtained in average healthy persons: these are estimated at about 5,000,000 for men, and about 4,500,000 for women, per cubic millimetre. In cases of disease a reduction to 2,000,000 or

3,000,000 is not uncommon: occasionally the figure is under 1,000,000, and in pernicious anæmia may sink to 500,000.

It is evident that in such methods the sources of error are numerous: the ruling of the squares may not be accurate, the dilution may be faulty, or the cover may not give a perfectly flat level, and so the estimated depth may be wrong, or the squares which we happen to count may not supply a fair average. The last source of error may be diminished by counting numerous squares or taking different drops, and the chances of error in some other parts of the process may be lessened by repeating the experiment. The most probable source of error which remains in this instrument after such precautions is with regard to the exact depth of the layer examined, as this depends not merely on the exactness with which the cell is made to such a minute depth, but also on the perfect flatness of the cover as applied to the edges of the cell. To secure greater preci-ion in this respect, special arrangements have been introduced in the *new* form of instrument devised by Malassez.

It must be remembered that a considerable range of error of observation must be allowed for, even when every precaution is taken in such measurements, and that the standard for the healthy is also a mere approximation.

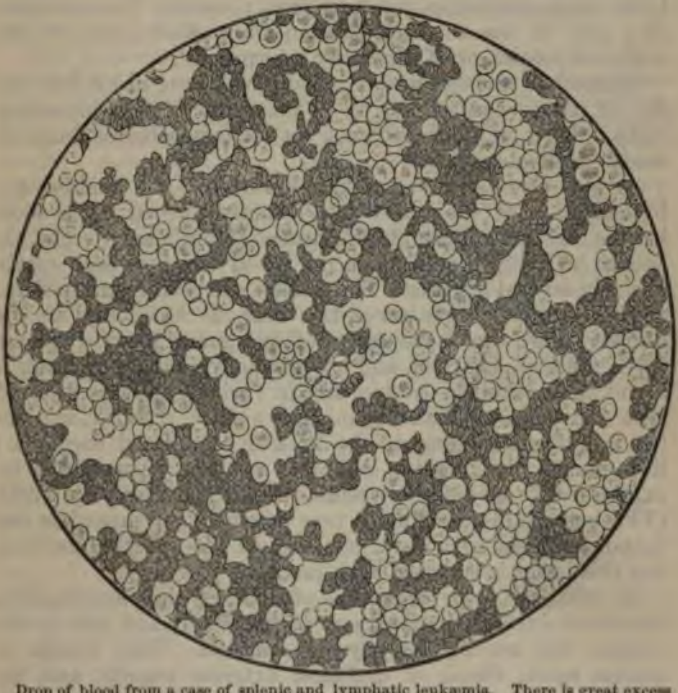
White Corpuscles.—The presence of an excessively large proportion of colorless corpuscles in a drop of blood drawn from a patient constitutes the condition now known as *leukæmia.* This condition in its most striking form is usually associated with evidence of changes in the spleen or in the lymphatic glands of the patient or in both. ("Splenic and Lymphatic Leukæmia:" see also p. 146.) But the number of the white relatively to the red corpuscles varies greatly in different persons, within the limits of health: in various diseases the proportion is likewise seriously disturbed, so that much care is required in formulating a diagnosis based on an apparent increase of the white corpuscles; in anæmic conditions and in cancerous affections, in particular, the white corpuscles are often increased. In preparing a specimen for microscopic examination we usually prick the skin of the finger suddenly by means of a needle, and occasionally it is better to produce congestion of the finger beforehand by the moderate compression of a ligature. We place the drop of blood on a perfectly clean slide and apply a cover-glass, taking care to avoid the soiling of the glasses by any exhalations from the skin of the patient or of the observer, and also avoiding any pressure likely to damage the corpuscles. The drop of blood, indeed, may with advantage be received on the under surface of the cover glass, held with a pair of forceps, and the cover-glass may then be slipped very gently down on to the microscopic slide: we aim at having just enough blood to fill the space between the two. The red corpuscles usually tend to run into *rouleaux*, and the white bloodvessels may generally be easily recognized from the difference of their shape, their somewhat larger size, and their want of color: their granular appearance also favors their recognition. The actual number of white blood-corpuscles visible in the *field* may then be counted, and in noting the result we should name the power of the microscope, specifying the number or the focal distance of the objective and the maker of the instrument; or we may attempt to estimate the *proportion* of the white to the red corpuscles by counting both in a given part of the field, noting 1–40, 1–20, 1–10, or 1–2, etc., as the case may be. An extremely well-marked case is represented in the figure, which is an accurate reproduction of an actual microscopic field. (See Fig. 53.) We should always estimate several different microscopic "fields" before arriving at an opinion, and it is very desirable also to have more than one specimen of blood to avoid accidental fallacies. The figures named above indicate the results frequently obtained in cases of disease: the normal proportion of the white to the red corpuscles is very much less, and great variations occur in connection with the time of food taking. (Estimates from 1–300 to 1–1200.)

Such methods of enumeration, however, are confessedly rough, and very subject to accidental variations. A more accurate determination demands the actual counting of the corpuscles of both kinds in a quantity of blood of known volume. By means of the hæmacytometer this can be done if we use diluting fluids which allow the difference in size between the corpuscles to be recognized.

The size of the corpuscles is a point of interest. This can be measured by using an objective of high power and an eyepiece micrometer with divisions of known value. Normal red corpuscles are about 7½ or 8 μ (micro-millimetres) in diameter (a micro-millimetre—μ—is $\frac{1}{1000}$th part of a millimeter—0.001 mm.). In anæmia the size of the corpuscles is often increased, say to 10 or 11 μ, and in other diseases alterations have also been observed.

The great proportion of the white corpuscles are, as a rule, larger than the red (about 12 μ), but when measured or even scrutinized closely, they are found to vary much in size, say from 4 to 13 μ. Their great variation in size is often seen in the blood taken from cases of leukæmia, some cases being characterized by abundance of the smaller size, some showing the larger size, and some both large and small: this combination is brought out in the drawing (Fig. 53), where large and small white corpuscles may be seen lying side by side.

FIG. 53.



Drop of blood from a case of splenic and lymphatic leukæmia. There is great excess of the white corpuscles; these are seen to be of various sizes. (Drawn from an actual "field" by Dr. John Wilson.)

Apart from micrometric investigation the size of the white corpuscles may be estimated by the eye in comparison with the red. In noting cases of leukæmia some indication as to the relative abundance of large or small corpuscles should be made, although the significance of this is not as yet very definite.

Very small corpuscles, more highly colored than the usual red corpuscles, and of globular shape, have been found in cases of pernicious anæmia: they are specially described and figured by Eichhorst.

Very small granular masses of protoplasm, sometimes irregular in shape, but sometimes spherical, are often found in the field; these, no doubt, sometimes arise from mechanical injury to the white corpuscles, resulting from pressure. In some cases they may be due to disintegration from other causes of the white corpuscles, or of Bizzozero's corpuscles.

Bizzozero's corpuscles, or "blood plates," are about half the size of red corpuscles (say 3 μ); they are colorless, biconcave disks. Their significance is not yet settled, either as found in health or disease.

Living Organisms.—Another branch of the microscopic investigation of the blood has recently opened up a most interesting and important department of pathology. The existence of living organisms in the blood has now been established in several diseases. The earliest discovered and perhaps the best studied organism of this class is that found in the disease known under the names of malignant pustule, splenic fever, anthrax, charbon, and other synonyms: the organism is found in the human subject and in various animals affected with the disease. This organism is a short, straight, motionless rod, about as long as the breadth of a blood corpuscle; it is named the *Bacillus anthracis*, and has been shown by experiment to be definitely related to the activity of the virus. (This bacterium resembles a very common and harmless one found in infusions of hay, etc., named the *Bacillus subtilus*, but this latter is endowed with motion.)

In relapsing fever organisms of another class are found in the blood during the paroxysm of the fever, and also in the relapse, but not in the apyretic interval. They consist of minute spiral fibrils of the most extreme tenuity, and the length is from two to six times the breadth of a blood corpuscle. They are named *Spirilla* (or by Cohn, *Spirochæte Obermeieri*); the spirals assume the various forms in their combinations.

The *Filaria sanguinis hominis* (Lewis) may also be mentioned: It is found in the blood (and the urine) of persons affected with a certain form of chyluria, but as yet only in hot countries. It is about the breadth of a blood corpuscle, and about $\frac{1}{75}$th of an inch in length, and exhibits active wriggling movements. It should be searched for in the blood during the hours of repose at night.

This subject is one of growing importance, but as yet it concerns experimental pathology more directly than regular clinical work.

Most of the subjects dealt with in this chapter are discussed pretty fully in all systematic works on the practice of medicine, and on diseases of children, or in special treatises on diseases of the chest and of the throat; for references to these last, see bibliographies appended to Chapter XVI. and Chapter X.

With reference to particular portions of this chapter, see Biot. Etude clinique et expérimentale sur la respiration de Cheyne-Stokes, Paris, 1878.—Hunter Mackenzie, Practical Treatise on the Sputum, Edinburgh, 1886.—Bizzozero et Firket, Manuel de microscopie clinique, microscopie légale, chimie clinique, technique bacterioscopique, deuxième édition française, Paris, 1885.—Klein, Micro-organisms, 3d ed., London, 1886.—Woodhead and Hare, Pathologica Mycology, Edinburgh, 1886.—Bennet, Leucocythæmia, Edin., 1852 Wickham Legg, Treatise on Hæmophilia, sometimes called the hereditary hemorrhagic diathesis, London, 1872.—Mrs. Ernest Hart, "Micrometric numeration of the blood corpuscles and the estimation of the hæmoglobin," Quart. Journal of Microscopic Science, vol. xxi., Lond., 1881.—Hayem (G), Recherches sur l'anatomie normale et pathologique du sang, Paris; also Leçons sur les modifications du sang, Paris, 1882.—Manson, The filaria sanguinis hominis, Lond., 1883.—Eichhorst, Die progressive perniziöse Anämie, Leipzig, 1878.

CHAPTER X.

EXAMINATION OF THE FAUCES, LARYNX, AND NARES.

THE FAUCES AND PHARYNX.

IN order to investigate the fauces and the parts in that neighborhood, it is necessary to bring the patient opposite a window or a lamp so arranged that the light will pass through the mouth to its posterior parts. The large laryngeal reflector may be used for the purpose of directing the light as required. If the patient be now made to open his mouth and take a deep breath, it will often happen that the fauces are at once visible. Frequently, however, the tongue interferes with the view; in its posterior parts, especially, it often mounts up, and lying in contact with the soft palate, completely fills up the back part of the mouth. It is sometimes a little difficult to dispose of the tongue, but by varying the procedure according to circumstances the difficulties may generally be overcome. It is sometimes sufficient to ask the patient to say "Ah," which causes the dorsum of the tongue to be depressed. Very often it is necessary to press down the tongue, and this may sometimes be done with the finger of the observer, but as a rule it is best performed with a spatula or the handle of a spoon. The best form of tongue depressor is a flat metal plate slightly curved, so as to give a hollow surface, fitted to adapt itself to the dorsum of the tongue. It is an advantage that the plate should have an oval aperture near its extremity, because the surface of the tongue will project through this, and by catching on the edges of the aperture prevent the instrument slipping. There is also an instrument which acts as a gag and speculum as well as a tongue-depressor. It consists of a wide tube attached to the plate which depresses the tongue. The wide tube occupies the anterior part of the mouth, and as the teeth rest on its upper and lower surfaces, the mouth is held wide open, and the passage is clear for vision. This instrument is self-adjusting. The spatula, in whatever form it may be, should be pushed well back before being brought to bear on the tongue, and should then be pressed firmly downward and forward.

When the tongue is thoroughly depressed, a full view is obtained of the uvula hanging down and tremulous in the middle line; the soft palate arching to either side of the uvula, and dividing into two pillars, which appear as slight projections, one in front of the other; the tonsils which lie between the pillars of the fauces and in the normal state do not project beyond them; and lastly, the pharynx, whose posterior wall is seen behind the uvula and soft palate. It is often possible by moving the spatula from one side of the tongue to the other, to expose the pillars of the fauces and the tonsils more fully than by keeping it in the middle line.

Besides the parts visible by simple inspection, it is to be remembered that the inferior and superior parts of the pharynx are concealed from view, being above or below the level of the mouth. The wall of the pharynx in its inferior part is attached laterally to the thyroid and cricoid cartilages of the larynx, and a space or pouch is left on either side between larynx and lateral wall of pharynx, the pharyngo-laryngeal sinus, in which foreign bodies sometimes lodge. In order to explore this the laryngeal mirror should be used, or the finger may be made to reach it through the open mouth. The superior part of the pharynx, that corresponding with the posterior nares, may also be explored by the finger or the laryngeal mirror. The finger can be passed upward behind the soft palate, and the roof of the pharynx as well as the openings of the posterior nares and Eustachian tubes felt.

In order to appreciate the changes which occur in the fauces, it will be necessary to familiarize one's self with the normal appearances. But this being premised, the principal points to be observed are these: The state of the uvula, whether it be unusually thick, or long, or (what generally goes along with these) unduly motionless; whether it be altered in color, in the way of bright red or dark red, the former usually indicating a more acute and the latter a more chronic inflammation. Is there any exudation or ulceration on the uvula? Then as to the fauces proper: Is the mucous membrane covering these parts thickened, or reddened, or ulcerated, or the seat of an exudation? Is there any enlargement or other change visible in the tonsils or their neighborhood? The condition of the mucous membrane of the posterior wall of the pharynx, as seen between the two posterior pillars of the fauces, is of great importance as it is often the seat of disease.

A systematic examination of each part with a direct view to determining the facts in regard to these various conditions will be of great consequence.

Morbid Appearances in the Fauces.—We have now to give some indication of the conditions actually met with in certain of the commoner diseases. The commonest of all is *catarrh*, in which, as a general rule, fauces, pharynx, and tonsils all take some part.

In *acute catarrh* we find the whole soft palate of a red color, with considerable swelling, especially of the uvula. The uvula is both longer and thicker than usual. The swelling shows itself most in the uvula because, on account of the looseness of its tissue and its freedom from adhesion to parts around, the inflammatory exudation has more room to accumulate here, and the uvula may become quite plump and bulky. The pharynx is also seen to be red, and in certain stages of the disease it may be found covered with a mucous or mucopurulent secretion. The tonsils are for the most part swollen, and they project toward the middle line.

Chronic catarrh of the fauces and pharynx may supervene on repeated acute attacks, but it has in most cases an independent origin. There are two forms of this disease generally recognized, the one designated *relaxed throat* and the other *granular pharyngitis*. In the former, there may be little visible alteration in the parts, even when the patient makes considerable complaint of fulness and stiffness in the throat. But in other cases there is swelling of the fauces generally, but especially of the uvula, which hangs down unduly and is not raised in the normal fashion by tickling it. The parts are unduly red, and varicose veins may be visible. The elongated uvula, by irritating the back of the tongue, the pharynx and even the epiglottis, sometimes gives rise to troublesome coughing. In *granular pharyngitis*, the mucous membrane of the pharynx is seen to be beset with little elevations about the size of millet seeds. As the disease advances these get more numerous and give to the pharynx a reticulated or generally granular appearance. This condition frequently extends to fauces, nares, and larynx, and as it is frequently due to overstraining of the voice by public speakers the designation *clergyman's sore throat* is used in many cases. There is seldom any ulceration in either form of chronic catarrh, and if ulcers be present they are very superficial.

Acute Tonsillitis—Quinsy.—In this condition we have an acute phlegmonous inflammation usually centring in the neighborhood of the tonsil, but extending to neighboring parts of the fauces and soft palate. It is to be remembered that in catarrh we have an inflammation of the mucous membrane simply, whereas here the submucous tissue and deeper parts are involved. The disease is usually unilateral, at least to begin with. The tonsil is enlarged, projecting toward the middle line as a bulky rounded swelling. As the inflammation increases and extends there are great redness and swelling of the pillars of the fauces and the soft palate, frequently passing on to suppuration. The abscess usually points at the anterior border of the tonsil, but may do so near the posterior wall of the pharynx. Cases have occurred in which the pus burrowing among the tissues has pointed externally near the angle of the jaw. The swelling in quinsy is generally visible externally, and as there is difficulty in swallowing and even in moving the jaw, as well as a peculiar muffled condition of the voice as if a bulky object had stuck in the throat, the disease is usually easy of recognition. It is often difficult, however, to arrive at a complete knowledge of the extent and principal seat of the inflammation on account of the swelling and the difficulty in opening the mouth. The local condition must often be inferred from exploration with the finger, assisted by the finger of the other hand outside. Fluctuation may be sometimes detected by placing one finger below and behind the ramus of the jaw, and the other in contact with the inflamed part. (Stoerk.)

Enlarged Tonsils.—This is a very common condition especially in children, due, apparently, to prolonged chronic inflammation. The disease is usually bilateral, but is frequently more advanced on one side. The swollen organs project on either side of the fauces as rounded irregular masses, sometimes meeting each other in the middle line. The obstruction in the fauces causes a peculiar thickness of the voice, and when extreme may seriously interfere with respiration, for the enlarged glands project toward the pharynx and posterior nares as well as at the fauces. The interference with respiration may be so serious as to cause malformation of the chest, from the exaggerated respiratory efforts acting on the yielding chest wall of the child. The so-called " pigeon-breast " is said to arise frequently in this way. A certain amount of deafness is often a concomitant symptom.

Scarlet Fever.—The condition of the fauces is that of an acute inflammation, and the appearances presented are very like those in acute catarrh. The uvula, palate, tonsils, and pharynx are generally, even in the mildest cases, red and swollen. The red and swollen mucous membrane is often covered with a layer of tenacious mucus, and in the more severe cases the tonsils may be so much swollen as almost to obstruct the fauces. All these processes are acute, developed in the course of a few hours. In the more severe cases there is more than a simple catarrhal inflammation. Instead of a layer of mucus on the surface, there appear specks and patches of a gray color, which seem to be adhering, although they can generally be removed without breach of surface. Along with this catarrh, as in simple catarrhal inflammation, superficial ulcers may form, which are not to be mistaken for the patches about to be mentioned as occurring in diphtheria. But sometimes there is actual sloughing of parts of the mucous membrane, and the sloughs coming away leave deeper irregular ulcers. This sloughing is, however, only met with in exceptionally severe cases, and scarcely in the earlier periods. It is to be remembered that the condition seen in the throat may extend to parts which are invisible, especially to the posterior nares. Important elements in the diagnosis of the scarlet fever throat will be supplied, of course, by the state of the tongue, the rash on the skin, and the other indications of the specific fever.

Diphtheria.—We have here also an acute inflammation of the same parts, but the appearances presented are very different. The mucous membrane here is red and swollen, but the attention is very particularly called to the existence of a peculiar exudation on the surface. Instead of the tenacious mucus, there appear on, or one might almost say, *in* the mucous membrane of the fauces, specks and patches of a white color. These are mostly met with on the uvula and palate, but they are often seen on the surface of the tonsils and pharynx, and even in various parts of the mouth. The patches are at first white, but they soon get darker in color from dirt and blood. This white material really involves the mucous membrane as well as appearing on its surface, and the consequence is sloughing of the superficial layers of mucous membrane. The sloughs and exudations separate and fall off, hanging from the surface as shreddy, ragged masses. It should be remembered that the inflammation does not usually confine itself to the parts seen, but often extends down into the pharynx and larynx, and upward into the posterior nares.

It is very important to be able to distinguish the exudation of diphtheria from conditions of a different nature, and to judge from the frequency with which simple diseases of the throat are called diphtheria, the distinction does not seem to be very easy. The exudation covering the parts in simple acute catarrh may be mistaken for that of diphtheria. All kinds of ulcers may be mistaken for diphtheritic patches, especially as they may be coated with a whitish secretion. Ulcers are met with in ordinary catarrhal inflammations, and these are most frequently seated on the soft palate, the tonsils, or the pharynx. Ulcers also occur in scarlet fever, and there they have similar seats. In smallpox, too, we may have ulcers and other evidences of acute inflammation in these regions, but the eruption on the skin will prevent any mistake being made. It should be remembered that the diphtheritic patch is an exudation on and in the mucous membrane, and is, therefore, raised above the surface, whereas an ulcer, of whatever kind, is depressed below it, although, of course, this depression may be masked by the presence of secretions on its surface. There is a form of disease which resembles the exudation of diphtheria more closely than any other, but which can hardly be mistaken for it, and that is the condition found in the mouth and known as thrush or muguet. These patches often extend to the fauces, pharynx, and even further, and as the peculiar white appearance in due to an excess of epithelium united into a membrane by the thread of a fungus, the patch may have a superficial resemblance to that of diphtheria. But the existence of these patches on different parts of the mouth, and their characters on close inspection, as well as the general symptoms, ought to prevent any such mistake. The microscopic examination may also assist us, by revealing the presence of a vegetable parasitic growth. (See Fig. 59.)

Syphilis.—The fauces are affected in a considerable proportion of cases in the secondary stage of syphilis, the conditions here coinciding with the eruptions of the skin, and partaking somewhat of their nature. We have an erythematous condition resembling a similar catarrh, but with the redness more defined in area and in the form of patches with somewhat abrupt edges. In a considerable number of cases there are *mucous patches* visible, chiefly on the pillars of the fauces and soft palate. These form small, slightly raised areas, generally round or elliptical in shape, and mostly symmetrical. In the later periods of syphilis extensive ulceration is the characteristic phenomenon. As pauses occur in the process from the effects of treatment or otherwise, cicatrization nearly always accompanies the ulceration. The adhesion and cicatrization of opposed ulcerated surfaces and the contraction of the cicatricial tissue often bring about very serious deformities, amounting sometimes to marked stenosis of the fauces.

The ulcers which form are usually situated on the soft palate or uvula, but may attack the pharynx. They generally cause considerable destruction of the mucous membrane, and in this way it is not uncommon to meet with cases in which the soft palate and the uvula are eaten away in great part. The loss of the soft palate will cause the person to have a peculiar nasal voice, and his pronunciation of certain letters will be imperfect, because he is unable to close the nares during phonation.

Almost the only disease likely to be confused with syphilis is cancerous disease with ulceration. If it be remembered that in syphilis there is always some other indication of specific disease, mistakes will generally be avoided.

Retropharyngeal Abscess.—It is necessary to bear in mind that abscesses occasionally form behind the pharynx, between it and the bodies of the vertebræ—retro- or post-pharyngeal abscesses. These abscesses, which mostly occur in children, sometimes originate in caries of the vertebræ, but various other causes have been assigned for their formation, such as direct injury to the pharynx from swallowing hot water or from the impaction of fish-bones. In many cases the cause is obscure, and the abscess is said to have an idiopathic origin. It is occasionally met with as a sequela of fever. The chief symptoms are pain, difficulty in swallowing and in breathing, usually with distinct swelling of the neck, which is frequently more apparent on one side than the other. The abscess may actually point in the neck, although it usually does so internally. If the finger be inserted in such cases, through the mouth, a tense swelling will be found behind the uvula and soft palate, bulging these forward and greatly obstructing the passage. The swelling may also be visible on depressing the tongue, but sometimes the mouth cannot be fully opened, or the abscess is too low to be visible. As the abscess increases, it may form a very serious cause of obstruction to the respiration and deglutition.

The elucidation of many of the matters above referred to may often be facilitated by the use of the finger. The state of the tonsils, for instance, or the consistence of any swelling can be thus explored; while, at the same time, information is gained as to the state of sensitiveness of the parts. It is often useful to assist the internal exploration by using the other hand outside, so as to place the tissues between the finger inside and that outside.

THE LARYNX.

Laryngoscopy.—The examination of the larynx is not a difficult process, but one which requires a certain amount of practice, patience, and tact. Before detailing the various steps in the procedure, it may be well to refer to certain matters connected with light and instruments. As daylight can seldom be had sufficiently concentrated, it is necessary to be provided with a lamp of some kind, and as it is important that the light should be near the level of the patient's mouth, the lamp must be capable of being raised and lowered. It is also well, where possible, to surround the flame with an opaque tube open only at one side, because this enables one to have the room dark, and the apparent intensity of the illumination is thereby increased. It is advantageous, where possible, to use some kind of light concentrator, which usually takes the form of a metal tube, at one side of which there is a strong convex lens. This may be adapted to a gas-bracket, or to a lamp, or it may be in the form of a movable apparatus applicable to any form of illumination. Useful adaptations have been devised by Dr. Morell Mackenzie. In choosing a lamp, one with a round flame is preferable, as there is always a non-luminous portion in a flat flame, whether of gas or lamp.

We require, in the next place, some apparatus for concentrating the light on the patient's fauces. It is not well, as a rule, to do this by the direct light of the lamp; a concave mirror having a rather long focus is the most convenient arrangement. In order that the hands may be free, it is requisite to have this mirror fixed to the head, which is done either by a strap passing round the head, or by a spectacle frame. The present writer has been in the habit of using the latter, and finds, among other advantages, that the ease with which it can be put off or on renders it very convenient. Whichever method of fixing be used, the reflector should be worn over one eye, in such a position that the eye which is covered by it can look through the hole which should always exist in the centre of the reflector. (It is not sufficient to have clear glass in the centre, but the reflector should be actually perforated.) The reflector should be placed over the eye nearest to the lamp, and in such a position that, while this eye is protected from the light of the lamp, the shadow of the reflector, projecting a little to the other side of the ridge of the nose, will screen the other eye from the glare of the lamp. If, for instance, the lamp be placed to the right of the observer, then the reflector will be placed over his right eye. The right eye, while protected from the lamp, will be able to look through the aperture at the patient, and the left eye will be shaded by the edge of the reflector, but will be free in other directions.

Of late years the electric light has been adapted for laryngoscopic purposes. The most convenient form is that in which a small Swan's lamp, with a system of convex lenses in front of it, is fixed on the forehead by an elastic band. As the source of light is at the forehead of the observer, the eyes are not exposed to the glare, and the hands are not likely to obstruct the rays of light. This method of illumination is exceedingly satisfactory, more particularly as it preserves the natural color of the parts.

The laryngeal mirror is a small mirror, preferably round in shape, mounted on a stem, and intended to be placed in the fauces of the patient, so as to catch the light and direct it down to the larynx, and at the same time reflect the image of the larynx toward the eyes of the observer. The observer should be provided with mirrors of different sizes, and he should see that the stem passes off directly from the border of the mirror, there being serious objections to the arrangement by which the wire forming the stem is carried a certain distance out from the mirror before being turned down to form the stem.

We may now turn to the procedure in the actual examination of the patient. In order to appreciate the difficulties of this process and to understand the mechanism, it is strongly to be recommended that the student will begin by practising on himself. A short paragraph on auto-laryngoscopy will be added to this description. For an ordinary examination the patient and observer should be seated on two chairs facing each other. The lamp may be conveniently placed to the patient's left; it ought to be about the level of his ear, and as near his head as may be convenient. The observer, with the reflector over his right eye, moves the reflector till the bright light falls on the patient's face. He then asks the patient to open his mouth, and observes that the head is so placed that the rays of light can find free access to the fauces. Frequently the head is bent to one side or the other, and this should be rectified. The patient should also be made to sit straight up, the tendency to lean the shoulders backward being prevented, and with the head inclined slightly backward. Before proceeding further, all these points should be noted, and a full illumination of the mouth obtained. At this stage it will often be impossible to see the fauces, because the tongue obstructs the view, and it is necessary in the next place to get it disposed of. It is not sufficient here to depress the tongue with a spatula, because when the laryngeal mirror is introduced, the back part of the tongue will probably be raised, and spatula and dorsum pushed against the mirror. It is most convenient to ask the patient to put out his tongue as far as he can, and to catch it with the finger and thumb of the left hand, a napkin being used for purposes of cleanliness, and also to prevent the organ slipping from the grasp. The protruded tongue should simply be taken hold of; it should not be dragged forward, all that is wanted being to prevent it slipping back and the dorsum mounting up against the soft palate. The tongue being thus secured, a full view of the fauces should be obtained, and it is well to be sure of this view before proceeding further.

The next procedure is the introduction of the laryngeal mirror. It should be slightly heated before being introduced, otherwise the breath condensing on it dims the surface. It is best heated by placing it over the lamp, and it should be held with the surface of the mirror downward so that this surface can be seen. The vapor produced in the combustion of the lamp at first condenses on the surface, but as the temperature rises the vapor is cleared away, and the mirror resumes its brightness. When this has occurred it is ready for introduction; but before introduction the back of it should be applied to the skin, say of the left hand, to see that it is not too hot. The patient will see you apply it to your own skin, and will not dread that he is going to have his throat burned. It should not be applied to the skin of the face, as, on account of the thinness of the epidermis, there are risks in examining syphilitic patients. The tongue being held by the left hand, and

FIG. 54.

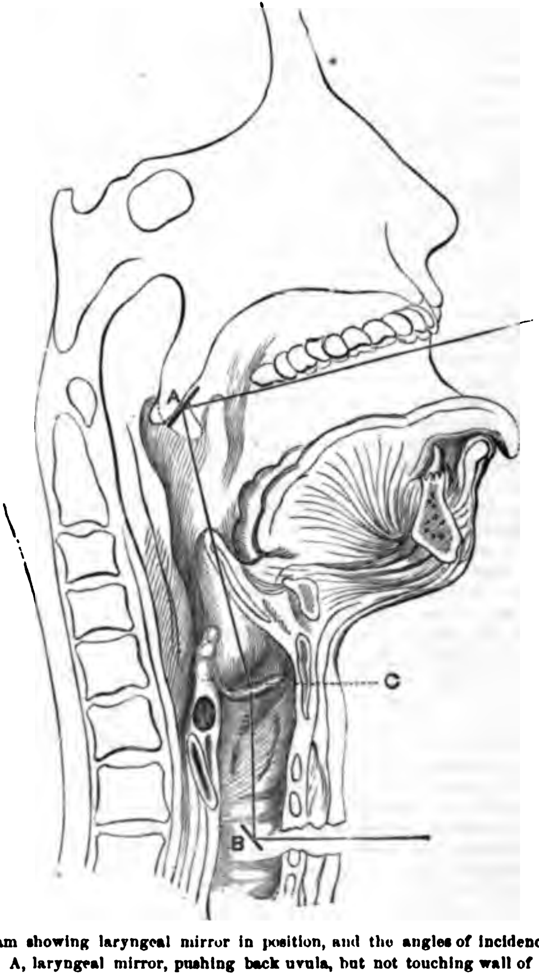


Diagram showing laryngeal mirror in position, and the angles of incidence and reflexion. A, laryngeal mirror, pushing back uvula, but not touching wall of pharynx. C, left vocal cord. B, mirror introduced through wound in trachea after tracheotomy—infra-glottic laryngoscopy. (Morell Mackenzie.)

the fauces continuously illuminated, the heated mirror is now to be introduced into the mouth, and in doing this the right hand will be kept to the left of the middle line, and slightly below the level of the patient's mouth, so as not to come between the lamp and the eyes of the observer. Fig. 54 shows the position to be aimed at for the laryngeal mirror, and indicates the paths of the rays of light passing to and from the larynx and reflected by the mirror. The mirror is passed backward, keeping its surface parallel with the tongue, and taking care not to touch any of the structures in the mouth with it. It is so introduced that the stem lies in the left half of the mouth, coming out near the left angle. The mirror is kept in the middle line, and is pressed against the uvula and soft palate, which it pushes backward and upward toward the posterior nares, but without touching the posterior wall of the pharynx. (See Fig. 54.) The instrument should be held delicately, but steadily, in the hand. Any tremulousness has the effect of tickling the fauces, and is apt to bring on reflex efforts at vomiting, which necessitate the withdrawal of the mirror. Just as the mirror is being placed, the patient should be asked to say "ah," and the instrument should be pushed home while he is doing this. The effect of pronouncing this vowel is that the mouth is at once fully opened, and the uvula drawn up somewhat.

The first object to come into view is the back of the tongue with its large circumvallate papillæ. Then the tip of the epiglottis will be seen, and it is probable that for some time the beginner will see little more. By carefully adjusting the mirror, however, and by asking the patient to say "*ah*," the movements of the laryngeal structures will by and by attract the eye and suggest such changes in the position of the observer and of the mirror as to bring the interior of the larynx itself into view. As a general rule, the mobile arytenoid cartilages will come first into view immediately behind the epiglottis. By inclining the mirror more downward, the vocal cords may be exposed as two pearly-white bands extending from the arytenoids forward as if into the base of the epiglottis. The great difficulty in the way of obtaining a full view of the vocal cords is the epiglottis, which often hangs down so that only the arytenoid cartilages, and sometimes not even they, can be seen behind it. Something may be done to raise the epiglottis by having the tongue well protruded, the glosso-epiglottic ligaments pulling the epiglottis upward. A great deal may also be done by asking the patient to say "*a*" (as in *hate*), for the pronunciation of this vowel causes the base of the tongue to be brought forward. It is difficult to say "*a*" with the tongue protruded, but an approach to it will be made, and in the effort the epiglottis will be raised. It is generally possible by this means to get a view of the cords even to their anterior extremities. But sometimes even this fails, and it is necessary to use a further method. The epiglottis is most fully raised in enunciating the vowel "*e*" (as in *me*), but with the mouth open and the tongue held out, it is impossible even to attempt to say "*e*." If the patient be asked, however, to say "*ah*," "*e*" (as in saying *aye* slowly and prolonging the *e*), the mere attempt to pass from the one vowel to the other will result in the pulling up of the epiglottis. This will generally be successful in the worst cases, but it is, of course, only a glimpse that one gets while the actual phonation is in progress.

Next to the difficulty with the epiglottis, the most serious obstacle to laryngeal examination is the tendency to retch which many patients present when the mirror is placed in the fauces. There are very great individual differences in this respect, and the difficulty can only be overcome by patience. In order to avoid it, the two principal precautions are to introduce the mirror with a firm hand and to avoid touching the pharynx or tongue with it. It is sometimes necessary to ask the patient to tickle his fauces frequently with a feather, in order to accustom them to the contact, and after a few days they generally get sufficiently non-sensitive. When the straining efforts set in, it is necessary to withdraw the mirror, as the pharynx contracts and completely closes the view. If the fauces are very exceptionally sensitive, the best plan is to cause the patient to suck ice for about ten minutes before the examination. The introduction of cocaine has enabled us to overcome most of these difficulties. If the fauces be painted with a four or five per cent. solution, an examination may be freely made in about twenty minutes.

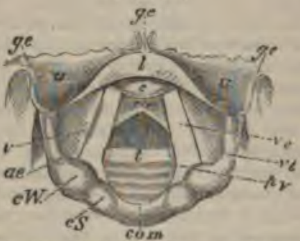
Auto-laryngoscopy may be practised in various ways. A very simple plan is that of Dr. Foulis, in which a globe filled with water is used to condense the light, and a little piece of looking-glass is placed above this condensor to enable the image to be seen. The globe may be had in a glass-blower's, and is of the kind used by jewellers to concentrate light on their work. It is mounted in a simple way on a candlestick, and placed in front of the light. The observer sits in front of it, allows the light to fall on his fauces, introduces the mirror after heating it, and observes the image in the piece of looking-glass above the condensor. Another simple method is for the observer to seat himself with the lamp in the same relation to himself as it would be to a patient. Then in front of him are fixed the ordinary laryngeal reflector held in some kind of stem, and side by side with it a small toilet mirror or hand-glass. The light coming from the lamp is reflected on the fauces just as in the case of a patient, and the image is seen in the mirror or hand-glass. A very ingenious method is that of Dr. George Johnson, and perhaps it is the best, as it needs no special apparatus. The observer sits down in front of an ordinary looking-glass, which has a lamp placed at one side. He puts on the ordinary reflector, and so manipulates it that he illuminates his fauces, as seen in the looking-glass, as if it were the fauces of a patient, and when this has been done, introduces the laryngeal mirror into his own fauces as before. The objection to this method is that the image being twice reflected is not very clear, but it approaches much more closely to the examination of a patient than either of the others. If the looking-glass be a thoroughly good one, and its surface well cleaned, this method presents little difficulty.

Palpation often affords considerable assistance in the investigation of the larynx. By external examination one may detect painful spots in the larynx. During vocalization the fremitus is readily felt by the finger placed near the thyroid cartilage, and by this means we may judge of the strength of the vibrations of the vocal cords. In some cases of unilateral paralysis of the muscles of the larynx the absence of fremitus on one side has been detected and the paralysis diagnosed without laryngoscopic examination.

The index finger may also be used to explore the interior of the larynx, and this method is often very useful where laryngoscopy is difficult or not available. The patient should be placed on a chair with the head inclined backward, and the tongue fully protruded. It will often be best to hold the tongue out with the left hand protected by a cloth, while the right hand is used for the examination. The index finger is now to be introduced at the left angle of the patient's mouth, and directed backward along the hard palate till the tip of the finger reaches the uvula. It is then to be bent into the form of a hook and suddenly passed downward, hooking round the epiglottis into the interior of the larynx. Any roughness or thickening of the epiglottis can thus be distinguished and also any swelling of the ary-epiglottic folds. It is sometimes advisable in this examination to keep the mouth open by a piece of cork inserted between the teeth.

It is impossible here fully to describe the appearances presented by the normal larynx; these should be made familiar by practice; but we must refer to the principal points which ought to be taken particular notice of. These are illustrated in Fig. 55, and may be followed by reference to the figure. The laryngeal mirror reveals the mucous membrane over the movable arytenoid cartilages at the back of the larynx. The general contour of these cartilages as well as the appearance of the mucous membrane should be noticed. Then the ary-epiglottic folds which form the lateral borders of the upper opening of the larynx, can be seen passing obliquely backward from the epiglottis. At the bottom of the larynx the true cords attract attention, appearing as flat pearly-white bands which are very mobile, and during vocalization come close together. Above the vocal cords and parallel with them, but separated by a space, are the ventricular bands which are often called the "false cords." They are folds of mucous membrane running in a direction from before backward. Between

FIG. 55.



The laryngeal image during quiet inspiration. *ge*, glosso-epiglottic folds. *u*, upper surface; *l*, lip, and *c*, cushion of epiglottis; *v*, ventricle of larynx; *ae*, ary-epiglottic fold; *eW*, cartilage of Wrisberg; *eS*, capitulum Santorini; *vc*, vocal cord; *vb*, ventricular band; *pv*, processus vocalis; *cr*, cricoid cartilage; *t*, tracheal rings. (Morell Mackenzie.)

each band and the corresponding vocal cord we can generally see a slit; this is the opening of the ventricle of the larynx, a shallow pouch, nothing of which is seen except the slit-like opening.

Morbid Appearances in the Larynx—The student having made himself familiar with the normal appearances of the larynx, will be prepared to attempt the investigation of morbid states. A laryngoscopic investigation will be undertaken whenever anything directs special attention to the throat. If there is any change in the voice, any hoarseness, or even a slight variation from the usual tone as appreciated by the patient's friends; if there is any pain or uneasiness either spontaneous or occasioned by speaking or swallowing, or on handling the larynx; if there is a cough which is not accounted for by the state of the lungs, and which may have its origin in the larynx; in all these cases an examination of the larynx will be called for and should be undertaken. In most diseases the pharynx and even the fauces are affected in common with the larynx, the structures being virtually continuous. It will not be possible to do more than indicate very briefly the appearances presented in certain of the more common diseases of the larynx.

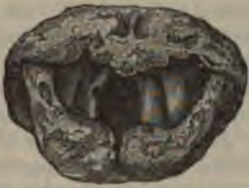
Alterations in color are of great importance in the larynx. The mucous membrane of the larynx generally has a bright red color, that of the epiglottis being much paler than the rest, while the vocal cords have a white tendinous appearance. Anæmia of the larynx is most manifest in the epiglottis as it is normally less injected than other parts. Hyperæmia is often peculiarly visible in the vocal cords, which may lose their white color and become strikingly injected. With this there is an abnormal redness of the mucous membrane generally which may precede that of the cords. It is to be remembered that nearly all the alterations in the larynx manifest themselves in differences of color, because the laryngeal image mostly gives a flat picture without the due perspective, and even ulcers are chiefly recognized by the alteration in color and brightness.

Acute catarrh manifests itself chiefly in an excessive injection of the mucous membrane generally, with some swelling. The swelling is not usually considerable, but in some cases it amounts to a distinct inflammatory œdema. (See "Œdema glottidis.") As there is considerable exudation on the surface, mingled with desquamated epithelium, the parts have often an excoriated appearance, which may be very manifest in the vocal cords.

Chronic catarrh attracts the attention of the patient by alterations in the sensations and in the voice, generally also by a certain amount of expectoration, which may, however, be small. On laryngoscopic examination it may require care to detect anything abnormal, as the changes, in the early stages at least, generally consist in alterations in color. The mucous membrane is unduly red, but the color is less vivid than in acute catarrh. In older cases the dull red may merge toward gray. The redness sometimes extends to the vocal cords, but it does so for the most part unequally. The mucous membrane as a whole is not usually much thickened, but there are often localized thickenings. The vocal cords may present an irregular granular appearance from limited thickenings, and there may be undue prominence of the ventricular bands or the mucous membrane between the arytenoid cartilages. These thickenings will cause a certain rigidity of the structures and thus interfere with vocalization. Considerable hypertrophy of the mucous membrane is, however, rare in chronic catarrh, although some cases have been described. The mucous membrane occasionally presents erosions or superficial ulcers, but there is rarely any deep ulceration.

Tuberculosis of the larynx (phthisis laryngea).—In the diagnosis of this disease we are to remember that we have to do with a condition characterized by infiltration of the mucous membrane similar to that in inflammation, but with a peculiar tendency to breaking down of the infiltrated structures so as to form ulcers, which have no inclination to healing. It is characteristic of the process, also, that it usually attacks, to begin with, limited portions of the larynx; the epiglottis, the ary-epiglottic ligaments, the vocal cords; and it is very often unilateral. The process in this way differs from an inflammatory one in its distribution, but it also differs in the absence of redness and in the great tendency to ulceration. If it begin in the epiglottis or ary-epiglottic folds, we have, in the first place, swelling of the parts, without redness. The swelling of the ary-epiglottic folds is often very marked in the early stages and it may be unilateral or bilateral. The swelling of the mucous membrane may persist for some time without ulceration, a fact that it is well to remember, as a case may readily be mistaken for one of simple catarrh. Ulceration occurs in the regular course, and is the most characteristic phenomenon of the disease. The ulcers are at first small and scattered, but they usually through time enlarge and coalesce, and, although at first superficial, they may cause, by degrees, considerable destruction, especially of the epiglottis (see Fig. 56). One vocal cord is often attacked by ulceration, or both. These ulcers almost never show any tendency to healing, so that cicatrices are not met with, this being in striking contrast with what is observed in syphilis. The ulceration and swelling go on side by side, and there is sometimes such a degree of localized swelling from infiltration of the mucous membrane as to produce a resemblance to a tumor. This is especially the case in the vocal cords, where, particularly at the anterior extremities, there may be, along with ulceration, considerable projection of the granulations.

FIG. 56.



Laryngeal phthisis, showing destruction of a large portion of the epiglottis and general ulceration. (Morell Mackenzie.)

Syphilis in the larynx presents similar characters to those observed in the fauces. We may have a catarrh not distinguishable in its appearances from ordinary catarrhs. Occasionally condylomata or mucous patches occur and may be seen as definite tumors on the cords or elsewhere, or as flat prominences. Syphilitic ulceration is not very common, but sometimes it is very extensive, and being accompanied by cicatrization and contraction it may produce the most serious destruction and distortion of the parts.

Inflammation of the cartilages of the larynx or rather of their perichondrium may be at the basis of a chronic laryngeal catarrh, or even of an acute catarrh. The disease usually goes on to the formation of abscess and frequently necrosis of the cartilage. Pain of a dull character, difficulty of swallowing, and external swelling, mostly accompany the process.

In *croup* and *diphtheria* we are seldom called on to examine the larynx, as the disease is generally obvious on other grounds; but if we are, the white exudation coating the mucous membrane will be visible. Here the exudation is not involved in the mucous membrane, as it is in the mouth and fauces, but lies on its surface, and comes away without ulceration.

Œdema glottidis must also be referred to in this place. This is a condition which may supervene on any acute inflammation of the larynx. It is met with, but not commonly, in acute catarrh. It occurs in the laryngitis induced by the pustular eruption of smallpox which often spreads to the larynx. It may be the consequence of syphilitic or tubercular disease, and sometimes supervenes on inflammation of the cartilages, or it may be a concomitant of erysipelas. The fluid accumulates in the submucous tissue of the larynx, the œdema being generally the consequence of an acute inflammation of the mucous membrane. Just as in œdema of the skin the fluid accumulates most where the subcutaneous tissue is loose, so here the œdema is greatest where the submucous tissue is loose. The mucous membrane of the larynx is mostly bound down pretty firmly to the subjacent structures, it is loose over the epiglottis, but especially in the ary-epiglottic folds. Accumulating there, the fluid swells up the mucous membrane; the epiglottis is often very prominent, and the ary-epiglottic folds form prominent rounded tumors. It is these latter which obstruct the larynx, and it is generally easy to reach and incise them with the aid of the laryngeal mirror. The vocal cords are not affected at all.

Growths are not uncommon in the larynx, and they are often situated on the vocal cords. If this be the case they alter the voice, usually making it hoarse. If the growth be on the cords it is easily seen, elsewhere it is not so distinct, especially if it be small. Most of these tumors are simple in their nature; but sometimes sarcomata or cancers attack the larynx, especially the latter. Cancers are mostly epithelial here, and are characterized by the warty, ulcerated appearance which they present.

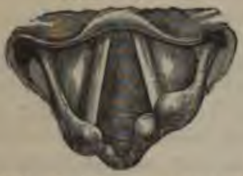
Paralysis of the Vocal Cords.—The movements of the vocal cords are governed by muscles, whose actions may be divided into three. In the state of rest, the glottis assumes a position intermediate between closure and the widest degree of openness—a position usually designated the cadaveric position, because it is that presented after death. From this position it may be moved by the adductors which close the glottis and render the production of the voice possible, or by the abductors which widen the glottis and allow of freer passage of air. In addition to these there are muscles which regulate the tension of the cords, and so produce variations in the pitch and certain characters of the voice. When the laryngeal mirror is introduced in a person with a normal larynx, there is usually visible a variety of delicate movements of the arytenoid cartilages and vocal cords, the parts being seldom at rest and usually varying with the movements of respiration. In quiet respiration they do not diverge much from the cadaveric position; but in deep inspiration they diverge widely, being drawn asunder by the abductors, returning during expiration. In vocalization they are brought closely together by means of the adductors. In coughing there is a closure of the glottis and a sudden opening of it. If the patient cannot speak above a whisper, or if there be a peculiar tone in the voice or cough, while the vocal cords present their normal appearance, then there must be some degree of paralysis, which may be unilateral or bilateral. There may be aphonia from general or respiratory weakness, which hardly warrants the name of paralysis.

Bilateral paralysis will occur usually as the result of some lesion of the central nervous system, but there are cases where the stems of both pneumogastrics or recurrents have been interfered with. The simplest form is where the loss of voice is due to hysteria or fright. In such cases the laryngoscope shows free movement of the cords during respiration, but the edges do not come together closely in vocalization. In coughing, however, there is complete closure of the glottis, showing that there is no true muscular paralysis, and it often happens that, while the laryngoscope is in position, the patient recovers her voice on being suddenly asked to repeat certain words. A true paralysis of the muscles of the larynx generally occurs in the later stages of bulbar paralysis and progressive muscular atrophy, being associated with paralysis of the tongue. The laryngoscope shows defective mobility of the laryngeal structures, in respiration, coughing, and speaking. Diphtheria is also sometimes followed by paralysis of the larynx, which is often associated with paralysis of the muscles of the fauces and may be inconsiderable as compared with the latter.

A number of cases have been published in which a bilateral paralysis of the abductors of the cords (the posterior crico-arytenoid muscles) has been asserted. It appears that both in unilateral and bilateral paralysis the abductors are usually earlier affected than the adductors, and they may be alone paralyzed. In this case the unopposed adductors produce a progressive narrowing of the glottis and increasing laryngeal obstruction. At first the obstruction may be paroxysmal and resemble spasm of the glottis, but it afterward becomes more or less persistent, and regularly increases in degree. There may even be spasm where one laryngeal nerve is interfered with by aneurism (Johnson, Schnitzler), this pointing to reflex paralysis of the abductors or stimulation of the adductors.

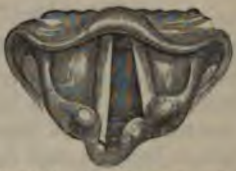
Unilateral paralysis is of more frequent occurrence, and is due to interference on one side with the nerves supplying the larynx. These nerves are the superior laryngeal and the recurrent laryngeal. The former supplies very few muscles, the crico-thyroid, and more doubtfully the muscles which depress the epiglottis during deglutition. It also supplies sensory fibres to the upper part of the larynx: when its stem is interfered with there is defective sensation and paralysis of the muscles which act on the epiglottis during deglutition. Interference with the stem of this nerve is so rare that it requires no further consideration. The inferior or *recurrent laryngeal nerve* is by no means unfrequently interfered with, especially by aneurisms of the aorta which are liable to stretch the nerve on the left side. The right recurrent nerve, curving round the subclavian artery comes very near the apex of the lung, and it is said to be frequently affected in phthisis pulmonalis, the pleurisy which is incident to this disease extending and setting up inflammation in the nerve, but the frequency of this occurrence has probably been exaggerated. Paralysis of the recurrent may also be due to enlargement of the thyroid from goitre or cancer, to cancer of the œsophagus, to tumors in the mediastinum; or these conditions, as well as aneurism, may give rise to bilateral paralysis, although this is rare. The regular unilateral paralysis may be complete or incomplete. It is to be remembered that the muscles of the larynx consist mainly of the adductors which close the glottis and the abductors which open it. During normal inspiration, the abductors open the glottis widely; during phonation the adductors close it. If there be complete paralysis of the one recurrent (usually the left) then the glottis, being acted on by neither set of muscles, remains half open, in the position which it assumes in the dead body (the cadaveric position). The arytenoid cartilage and the cord remain motionless both in inspiration and phonation (see Figs. 57 and 58), while the cord of the other side moves freely. During phonation, the sound cord comes forward to the middle line or projects beyond it, and may be carried so much beyond the middle line as to meet the paralyzed one, the cartilages partly overlapping, particularly when a high note is sounded. When the paralysis is incomplete there is diminished movement of the glottis. The paralysis is sometimes incomplete in respect that it affects certain muscles more than others; and it appears, for some unknown reason, that the fibres of the nerve which supply the abductors are more frequently paralyzed than those which supply the adductors. As a result, the adductors act continually without opposition and retain the cord of the affected side in the position of phonation. In that case the two cords will go closely together during phonation, but the affected one will not retire during inspiration.

FIG. 57.



Paralysis of left recurrent nerve. Image during inspiration—the left cord in the cadaveric position. (Morell Mackenzie.)

FIG. 58.



Paralysis of left recurrent nerve. Image during phonation—left cord in cadaveric position. (Morell Mackenzie.)

The voice and cough are often greatly altered in these various affections of the muscles. Most characteristic is the loud clanging cough met with in many cases of aneurism. As the glottis closes imperfectly the patient uses very forcible expirations in his coughing, and there is a great rush of air through the glottis. As the unaffected cord is rendered tense a loud tone is produced, but it is of an impure character, giving the peculiar clang to the cough. As the cord on the affected side does not retire in inspiration, but retains the cadaveric position, or may even be in the position of phonation, there is always a certain obstruction, during inspiration, which gives rise to a stridulous sound. The voice is sometimes reduced to a whisper, but more frequently it has a peculiar clanging sound, being very imperfectly under the command of the patient, sometimes suddenly assuming the falsetto character.

Spasm of the glottis or laryngismus stridulus, which is comparatively frequent in children and may complicate bronchitis, whooping cough, etc., scarcely calls for special notice here. The condition seldom admits of observation with the laryngoscope, and is sufficiently indicated by the difficulty of respiration and the stridulous sound which accompanies it. A more or less permanent stridor may occur in obstruction of the glottis by tumors or swellings in the larynx; and it is to be borne in mind that in cases where there is already considerable obstruction, it not uncommonly happens that spasm comes on and renders the obstruction complete, sometimes with fatal results, if tracheotomy be not resorted to.

INVESTIGATION OF THE NARES.

Rhinoscopy consists in the inspection of the nares; this may be done by inserting a mirror behind the uvula, with its surface so placed as to reflect the image from the posterior nares. The mirror must be a small one, not more than five-eighths of an inch in breadth, and it should be bent so that its surface is at right angles with the stem. It is generally necessary also to use a tongue spatula, which should be introduced further back than usual. The patient sits with his head erect, or slightly bent forward, and the light of the lamp is to be reflected on the fauces exactly as in laryngoscopy. The tongue having been depressed with a finger or a spatula, the mirror, after being heated, is introduced into the back of the throat, and placed so that its surface forms with the horizon an angle of 130 degrees. The mirror may be conveniently introduced first on one side of the uvula and then on the other, so that an image may be obtained of the two posterior nares separately. The uvula often obstructs the view, and so does the soft palate, if the distance between the anterior pillars of the fauces and the wall of the pharynx be too short. A hook has been devised for raising the uvula, but it is in most cases of doubtful utility. The image obtained is at first rather difficult to understand, and especially so, as it is impossible to get a full view of the posterior nares at once, and it must be taken piecemeal. The most prominent appearance is the middle turbinated bone; below it is the inferior, and above it, somewhat in the distance, the superior. The septum is also to be seen; and, by moving the mirror, the trumpet-shaped extremities of the Eustachian tubes. It must be confessed that the examination is often unsatisfactory; and those who desire to follow it out more fully should consult some of the special works, such as that of Morell Mackenzie.

The anterior nares may be examined by causing the patient to bend his head far back, and then directing the light by means of the reflector into the nostrils. The nostrils may be dilated with a blunt probe, or other means. A spatula has been devised for dilating the nostrils, and so exposing the anterior nares.

Rhinoscopy will be called for when the existence of a chronic discharge from the nares, or a persistent obstruction, directs special attention to these parts. Sometimes, also, the condition of the openings of the Eustachian tubes in deafness may be discovered by means of rhinoscopy. When a view of the nares is obtained it may be possible to observe any undue redness, or thickening of the mucous membrane, the existence of ulcers, the proximate source of discharges, etc. The existence and exact seat of polypi, which frequently obstruct the passage, may also be discovered by this means.

The most complete English work on these subjects is Morell Mackenzie's Manual of Diseases of the Throat and Nose, 2 vols., London, 1880–84: this author has also written the article on the larynx in Reynolds's System of Medicine, vol. iii., and monographs on several departments of the subject.—Lennox Browne has a general work entitled The Throat and its Diseases, London, 1878, which is illustrated by numerous colored lithographs. This author has also published in conjunction with Emil Behnke two works chiefly connected with singing, namely, Voice, Song, and Speech, London, 1884, and The Child's Voice, London, 1885. Behnke has also a book on the mechanism of the human voice.—There are several important works by J. Solis Cohen, of Philadelphia.—Prosser James has a small work on the laryngoscope, while Sir G. Duncan Gibb's book, which led the way among works of this description, retains a permanent value.

The laryngoscope as a practical instrument was worked out by Czermak, whose original work on the subject bears date March, 1858. Many attempts, more or less successful, had been made to illuminate and examine the larynx, an account of which will be found in Morell Mackenzie's manual; but it was not till Czermak took the matter in hand, with the laryngeal mirror devised by Signor Garcia, that the laryngoscope, as we now know it, came into existence.

The principal systematic works in German are those of Stoerk, Tobold, and Türck, and the article on the "Larynx" in Ziemssen's Encyclopædia.—In French, the works of Mandl, and Fauvel are the chief.—A work by Gottstein on diseases of the larynx has been translated by M'Bride, Edin., 1885.

There are numerous works on special departments of the subjects such as tumors and paralysis of the vocal cords. On the former, the works of Butlin, On Malignant Disease of the Larynx, London, 1883, Bruns, Die Laryngotomie, Berlin, 1878; and Morell Mackenzie's manual may be named. In the last mentioned a full literature of the subject is given.

Paralysis of the cords is very fully treated in Mackenzie's manual and Stoerk's Klinik, Stuttgart, 1880.—Paralysis of the abductors is specially discussed by Semon in two articles in the Clinical Society's Transaction, vols. xi. and xii, London, 1878 and 1879.—The subject of paralysis in general is also discussed in the Transactions of the International Medical Congress, vol. iii., London, 1881.

Seech, Diseases of the Mouth, Throat, and Nose, translated by Dr. Blaikie, Edin., 1886.—Baber, Guide to the Examination of the Nose, London, 1886.

CHAPTER XI.

DISORDERS OF THE DIGESTIVE SYSTEM.

THE digestive organs are often deranged in a great many diseases of a general nature, as well as in local affections of these organs themselves; an inquiry into their state becomes thus an important part in nearly every case as a matter of diagnosis; but, perhaps, the prognosis and treatment depend even more particularly on this investigation. Fevers and inflammations of nearly every kind affect the digestive functions, more or less seriously, and many cerebral and other nervous disorders likewise do so; general constitutional diseases, anæmia, Addison's disease, leukæmia, etc., also disturb them more or less profoundly. Affections of the kidney, uterine disorders, and pregnancy, frequently declare themselves first by vomiting. Diseases of the œsophagus, stomach, bowels, liver, pancreas, peritoneum, and mesenteric glands, necessarily derange the digestive functions; affections of the digestive organs may be primary, or they may be due to mischief in contiguous parts (aneurisms, abdominal tumors, etc.).

This complexity in the etiology of digestive disorders necessitates a very careful investigation of the different groups of symptoms; each particular disorder has often to be scrutinized in respect of the duration, the proximate cause, and the relative date of the symptom in question.

The appetite is usually more or less impaired (anorexia) in all serious diseases, especially in those with high fever or other acute symptoms, and in those which involve the digestive organs in a direct manner. We should ascertain the habitual character of the appetite in health; we also inquire whether there is any remaining desire for particular kinds of food, and what these are, whether the appetite is capricious as to special kinds of food or abnormal articles, or at particular times; whether the loss of appetite is associated with nausea or loathing of food; and whether actual sickness and vomiting occur on attempting to overcome this repugnance. Many influences not usually thought of as diseases are often at work in causing impaired appetite: grief or anxiety, and depression of spirits, want of variety in the food or of company at meal-times, want of fresh air and exercise, and the use of certain drugs, including opium, chloral, and alcohol (even in medicinal doses), are often responsible for the absence of appetite complained of by our patients.

In some forms of nervous disease there is an inordinate appetite (boulimia) arising from a sense of want or emptiness, very soon even after a meal: certain forms of indigestion are likewise characterized by a sense of spurious hunger. In diabetes also the appetite is sometimes excessive. In certain states of bodily and mental disorder an unnatural appetite (pica) for the most extraordinary articles may sometimes be noticed; this may be found at times in chlorosis, pregnancy, and insanity. (Compare Chapter VIII., p. 316.)

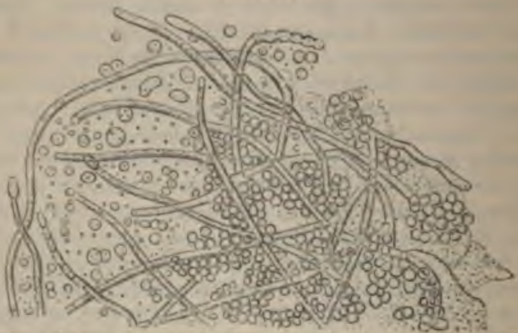
Thirst is a very frequent complaint in all diseases associated with much pyrexia; in such cases, notwithstanding the quantity of fluid consumed, the urine is usually scanty. In several forms of stomachic derangement, also, the presence of thirst is a frequent symptom, and in such cases the urine may be abundant, although otherwise normal. When from any cause vomiting is excessive there is apt to be great thirst superinduced. In certain forms of Bright's disease, and very notably in diabetes, the complaint of thirst often directs our attention to the examination of the urine, and in such cases a large consumption of fluid is usually found to be associated with frequent micturition and the passing of a large quantity of urine; the further examination brings out abnormalities in the specific gravity, and usually, also, as regards the presence of albumen or sugar. Particular articles of diet (salt fish, etc.) often cause temporary thirst, and the use or abuse of alcohol is frequently followed by more or less thirst and dryness of the throat, especially in the morning. Some medicines—opium, and more especially belladonna—are apt to cause dryness in the mouth and throat with a sense of thirst.

THE STATE OF THE TONGUE.

This affords valuable indications respecting the digestive functions, especially when the disorder is due to the influence of constitutional disturbance from febrile or inflammatory disease. Indeed, the progress of a febrile attack can often be traced both in its increase and decline by corresponding changes in the state of the tongue. Many points bearing upon the tongue have been already discussed in connection with taste and nervous disturbance (pp. 193, 225.)

The presence of a fur or coating on the tongue should be described as to its extent, whether the edges and tip are clean, and as to the color and thickness of the fur, which is sometimes very dense. Different from the ordinary coatings of digestive disorder are the white soft patches of muguet (parasitic stomatitis or aphthæ, popularly known as "thrush," "frog," etc.): these are often seen in children, especially in those who are fed artificially; but they may likewise occur in others, and even in adults suffering from chronic diarrhœa and exhausting diseases approaching a termination; these white spots and patches are found, also, on the mucous membrane of the cheek and throat; they are due to the presence of a vegetable parasite (oïdium albicans, see Fig. 59), which may be seen with the microscope, after removing such spots with the point of a knife, and digesting them in liquor potassæ. (For distinction from white diphtheritic patches, see Chapter X., p. 378.) Very much rarer than this is the presence of blackness in the tongue, associated with hypertrophy of the filiform papillæ and the presence of microörganisms differing from the ordinary leptothrix buccalis. The dark streaks on the mucous membrane of the tongue, cheek, and lips observed in Addison's disease, are local manifestations of a general pigmentation.

FIG. 59.



Oïdium albicans, the vegetable parasite of *muguet* or *thrush*. (Reduced from Ch. Robin.)

The dryness of the tongue is the next point to be considered. This may be tested by applying the tip of the finger to it as well as by looking at it. The dryness may exist either with or without coating. In advancing typhus, pneumonia, surgical fever, etc., we often find the tongue becoming dry, brown, and hard, so as to be not unlike roasted leather. Along with this we often see sordes on the gums and teeth: this dirty-looking matter consists of epithelial débris, fragments of food, and parasitic growths all mixed up together. In less severe or receding forms of the same condition, the dorsum may be dry, and the edges and tip somewhat moist. But the tongue may be dry in whole, or in part, without much, if any, fur, in which case it has a red glazed appearance; or, if some parts are less dry than others, we may see streaks here and there, and perhaps small patches of fur on the dorsum: this state is not unfrequently complicated with hacks or cracks, often very painful: a similar condition frequently can be traced further back in the fauces.

The red raw tongue is seen in certain febrile states (especially enteric and scarlet fevers); this may succeed the intensely furred condition already referred to; the whole of the thick coating sometimes disappears with great quickness, leaving a very red moist surface exposed. This sudden desquamation is scarcely so favorable as a more gradual cleaning. This red raw tongue, in such a case, may become dry and glazed in the further progress of the fever.

The "strawberry tongue" is characterized by great distinctness of the papillæ, associated with considerable redness, and not unfrequently with thick white fur in adjacent parts. This strawberry tongue is common in scarlet fever, not usually at the very beginning, but after some days' continuance of the fever. An appearance closely resembling it may also be found in cases of simple digestive disorder.

Enlargement of the circumvallate papillæ, at the back of the tongue, is not uncommon in cases characterized by various dyspeptic symptoms, and often associated with a pitted condition of the tonsils.

Little blisters on the tongue (aphthæ), and various degrees of ulceration, supply the evidence of the different forms or degrees of stomatitis (vesicular, ulcerative, gangrenous): these are often associated with salivation, fetor, and much febrile disturbance.

A swollen, sodden appearance of the tongue with very distinct indentations on the edges, corresponding to the teeth, is often found in dyspepsia of various kinds, including those connected with the free use of alcohol. Swelling of the tongue occurs in *salivation* by mercury; the rest of the mouth participates in this action; the mucous membrane of the cheek opposite the teeth should also be examined; there is usually a well-marked "mercurial fetor." Iodide of potassium also causes at times swelling and salivation. Glossitis (from these or other causes) may lead to swelling so great that the tongue cannot be kept within the mouth.

Swellings under the tongue (ranula) and hardness, nodulation, or patches, from syphilis and cancer, belong rather to surgery than medicine. Occasionally salivary calculi give rise to much swelling and pain in this situation.

Nearly all of these last-named alterations, associated with swelling or enlargement of the tongue, may lead to difficulties in speaking and swallowing; they sometimes render eating or drinking painful or impossible.

Paleness of the tongue from anæmia, *lividity* in cyanosis, *coldness* in cholera or collapse, and patches of *ecchymosis* in purpura, are further points of an obvious character which should be noted when present.

In examining the tongue we frequently detect a foulness in the breath. This is often due to sore throat, rotten teeth, decomposing particles of food or blood in the mouth or nose, ozæna, and gangrene of the lung; by closing the nose and mouth alternately, holding the breath, exploring the teeth and nostrils, etc., we can sometimes make out these sources of fetor. It may, however, arise also from disorder of the stomach due to grave febrile disorders, to prolonged constipation or intestinal obstruction, to errors in diet, to particular forms of dyspepsia with fetid eructations, or to the chronic and baneful influence of alcohol, opium, and chloral. Some medicines impart a disagreeable smell to the breath, and among these the garlic odor of bismuth may be mentioned, as it is apt to be overlooked owing to the absence of smell in the medicine itself; it is not always present during the use of this drug, and seems due to the occasional presence of tellurium in certain parcels as an impurity. Various drugs likewise affect the breath from their volatility.

VOMITING.

Vomiting should be considered in respect of what appears to be its immediate cause; we inquire as to whether it is connected with anything taken into the system, as food, drink, and medicine; or into the lungs by direct inhalation, or in connection with emanations of various kinds; or by absorption through the skin, or through cuts and abrasions; the possibility of poisoning, intentional or accidental, or in connection with the occupation and habitation of the patient, must not be forgotten. The presence or absence of pyrexia often guides us in deciding as to the vomiting being symptomatic of the poisoning of the specific fevers. We inquire, further, whether the vomiting is associated with the position of the patient, induced, for example, on moving or on rising from bed; whether it only comes on at particular times, as in the morning, or in connection with fits of coughing; whether it is associated with, or preceded by, sickness, nausea, or pain in the stomach and liver, or connected with jaundice, or with disorders of the bowels. Vomiting is likewise frequently associated with headache, pain in the back, fever, paralysis, convulsions, insensibility, dropsy, disease of the urinary organs, and disorders of the menstruation. We must inquire in certain cases whether there has been an exposure to the sun, any injury to the head or belly, any surgical operation, or any other obvious fact of this kind in the previous history of the patient.

When due to ingesta, the vomiting may be immediate, or it may not occur for many hours; some assistance may be derived from the known tendency of the patient to vomit readily, or after certain articles. In such cases when the vomiting is not immediate, there is usually some period of sickness, of coldness, faintness, or giddiness just before the vomiting occurs, and there is often a history of some previous derangement of the *primæ viæ*, perhaps with furred tongue, constipation, etc. When sickness and vomiting are due to these last-named causes there is usually great and permanent relief from the emptying of the stomach, but sometimes improper food and certain medicines (antimony, chloroform, opium, etc.) set up a more prolonged vomiting, due probably to some changes being induced by them in the digestive organs (gastritis, jaundice, intestinal catarrh, dysentery, etc.), as evidenced by the other symptoms of these complaints. Allied to these is the vomiting induced by the use of rich food in excess, or the morning sickness so common in those who drink alcohol regularly and freely, although perhaps never to the extent of causing obvious intoxication, or in those who are addicted to the frequent use of sedatives. The vomiting in alcoholic cases may be due to a practice long continued and not to any one act which we can name: these attacks are often called "bilious" by the patient, and ascribed by him to anxiety in business, vexation, etc.

When the stomach has been upset from any cause, many things irritate it which would not otherwise do so; when even a little cold water is almost immediately rejected, we have evidence of very great irritability of the stomach.

The influence of the recumbent position in helping to ward off sickness and vomiting, applies to nearly every variety of the disorder; but in some cases, including cerebral affections, the effect of change in position is very great; in uterine flexions and in pregnancy, the erect position often determines vomiting at once, and this is no doubt one of the reasons why the sickness is chiefly marked in the morning in many of these cases. In cases of vomiting due to abdominal abscesses, peritonitis, and general debility, the influence of position, and the importance of perfect rest after swallowing anything are often very marked. The sickness caused by the rolling of a vessel at sea, by rapid rotation, by driving with the back to the horses, etc., may be mentioned in this connection, although such sickness is probably caused in some way through changes in the cerebral circulation.

The pains and discomforts associated with vomiting are very variable. In fevers and inflammatory diseases the vomiting is usually accompanied with more or less headache, and often with pain in the back, and a feeling of soreness in the limbs, or with general malaise. But in addition to this there is often pain in the chest, over the liver or gall-bladder, the bowels, kidneys, bladder, ovaries, uterus, testicles, etc., according to the special organs attacked.

Pain in the stomach itself should be inquired into as to whether it appears immediately after a meal (as is common in gastric ulcer), or only after the process of digestion has actually been going on (dyspepsia); whether the pain is associated with much wind in the stomach, and whether it is relieved by eructations, or by the act of vomiting. This relief is often very marked in cases of dyspepsia and of dilatation of the stomach. The sense of sickness or nausea usually precedes vomiting from most causes, but not unfrequently it is absent in the vomiting due to cerebral disease, and occasionally in that of renal disease, so that "causeless vomiting" should always be considered from this point of view. Apart from serious cerebral lesions, morning sickness is not uncommon in those whose brains are overtaxed to a serious extent. Vomiting without any very obvious cause is also found in Addison's disease, pernicious anæmia, and other constitutional disorders.

In cerebral disease violent headache often accompanies the vomiting, and headache is very often associated with the sickness and vomiting due to indigestion. The combination of headache and vomiting, both in extreme forms, is seen in the nervous affection known as "sick headache" (migraine), but in this case the headache is usually unilateral (hemicrania), and the duration of the attack, in an acute form, varies from a few hours to one or at most two days. While pain in the back and vomiting are common in all febrile affections, such a pain with very marked tenderness in the spine may sometimes denote a spinal meningitis, or some other form of inflammatory mischief in the cord. Violent paroxysms of profuse vomiting may form the leading feature of the "gastric crises" occurring in locomotor ataxy.

Disorder of the bowels frequently indicates the cause of the vomiting with which it is associated. Vomiting is often severe at the beginning of summer diarrhœa, especially in children, and it is common also in cholera and dysentery; it sometimes accompanies the act of defecation. Severe vomiting and diarrhœa sometimes occur in the various forms of peritonitis. This combination is also found at the beginning of certain cases of malignant scarlatina and measles. Vomiting is likewise common in cases of prolonged constipation, whether from general disorder of the digestive organs, or from serious obstructions with the attendant inflammation, due to hernia, internal strangulation, invagination, etc. Examination of the hernial regions, of the state of the abdomen, of the character of the vomited matters, and of the stools, if any, should never be neglected.

Vomiting is also a leading symptom in the various forms of local and general peritonitis, often associated with constipation and flatulent distention of bowels.

Irritation of the fauces, produced by choking, or by an infant's sucking too greedily, or perhaps by an elongated uvula, or by coughing, very often produces vomiting. Various forms of cough, especially when associated with profuse expectoration, are apt to excite vomiting. The paroxysms of whooping cough are often terminated by an act of vomiting. It may be noticed in passing that severe vomiting and retching may set up a form of coughing and hawking which may seem again to induce further vomiting.

Menstrual irregularities, uterine flexions, pelvic inflammations, and other forms of uterine and ovarian disease, are frequently responsible for severe and persistent vomiting with great sickness. Any history of suppression of the menses, within the childbearing period of life, associated with this symptom, should lead us to consider the question of pregnancy.

In the vomiting due to renal disease we usually have important assistance from the state of the urine. Not a few cases of so-called "biliousness" with sickness and vomiting are found to be due to this form of disease. Vomiting occurs at times in all forms of kidney affections, but the passage of renal calculi, and the poisoned state of the system known as uræmia, may be named as conditions specially likely to give rise to it. The occurrence of vomiting in connection with a great diminution of the urine in renal disease is always of very serious import in this respect. The vomiting and other alarming symptoms observed in retrocedent gout may likewise be mentioned in this connection.

Vomiting is an habitual accompaniment of the paroxysmal and excruciating pains in the hepatic region due to the passage of gall-stones; it usually precedes the jaundice due to this cause. A certain amount of vomiting, indeed, is a common precursor of jaundice from whatever cause, although it is occasionally quite absent. (See "Jaundice," Chapter XII.)

The quantity of matter ejected, and the sensation of sourness, burning, bitterness, fetor, etc., experienced during the act are of importance in judging of the size of the stomach and of the changes which the contents of the stomach have been undergoing. (See "Vomited Matters," *infra.*)

Œsophageal vomiting differs from ordinary gastric vomiting in the relatively small quantity which comes up, and in the absence of effort and straining during the act. It bears some resemblance to the sudden emptying of an India-rubber hose on removing it from a large water tap. It occurs in cases of stricture of the œsophagus, especially when there is dilatation of its cardiac extremity. This is almost always a malignant disease, but it may also arise from injuries (burns and caustic liquors).

Vomited Matters.—These should always be preserved for inspection, especially in cases of suspected poisoning, and when the vomiting is of an obscure character.

The quantity vomited at a time is often important, as it helps to reveal the size of the stomach, and to indicate the extent to which the meals, of several days it may be, are retained. Excessively large quantities are ejected in cases of dilatation of the stomach due to cancer of the pylorus, or other forms of stricture. These excessive quantities are often only ejected at intervals of two or three days, and the disproportion between the amount swallowed on a given day and the amount vomited, may serve to indicate the retention of several days' food. The relatively large quantity vomited in certain cases after the swallowing of a small amount of bland fluid, serves usually to reveal somewhat serious congestion, if not erosion or ulceration, of the stomach. The "coffee grounds" vomiting in such cases is due probably to the exudation of blood, whose character has become altered by the juices of the stomach. (See "Black Vomited Matter.")

The obvious character of the vomited matters often explains an attack of vomiting, as when we find unripe fruit, undigested pie-crust, and similar articles brought up by a sick child, or when we find alcoholic liquors vomited by a drunken man. The degree of digestion undergone by the ejected matters may be important, as indicating the length of time the food has been retained. The curdled milk vomited by infants does not necessarily imply an undue acidity of the stomach, but the excessive tenacity or solidity of the curd may indicate that the particular milk given cannot be digested.

Occasionally a recent meal is retained while former meals which have been so far digested are ejected, owing probably to their being more fluid. The character of the matter vomited, as experienced by the patient, especially as to sourness, bitterness, fetor, etc., is sometimes of value; the smell and reaction can be ascertained by ourselves. The conjunction of great acidity in the vomited matters with alkalinity of the urine has often been noticed.

The smell is valuable as assisting our recognition of the nature of the matters vomited. It is further of great importance when the odor can be recognized as distinctly fecal. Occasionally various forms of decomposition simulate this odor; but when it is quite unequivocal it indicates some form of obstruction or strangulation of the bowel, or some fistulous communication of a lower part with a higher part of the intestine, or with the stomach itself. The yeasty or frothy appearance of the vomited matters indicates that fermentation has been going on in the contents of the stomach. This is often associated with the odor peculiar to this process, so that the smell of the vomited matter and of the patient's breath resembles that of an old beer or porter barrel. Torulæ and sarcinæ should be searched for in such cases. (See "Microscopic Examination," p. 406.)

Blood in large quantity can be generally recognized as such (hæmatemesis). It is usually darker and less frothy than that brought up from the lungs. Large hemorrhages from the stomach are commoner in simple gastric ulcer than in cancer, although they occur in both. They likewise occur in connection with portal congestion due to cirrhosis of the liver. Occasionally large quantities of blood are vomited from the opening of an aneurism into the œsophagus; such an accident is usually rapidly fatal. Blood in small quantities, causing florid streaks amongst the mucus and vomited matters, is not uncommon in any very violent attacks of vomiting if long continued. Such streaks are specially apt to appear in cases associated with congestion and catarrh of the stomach from diseases of the liver or other causes. *Dark fluids*, resembling "coffee grounds" or "sooty fluids," are almost always composed of altered blood acted on by the digestive juices. They are found frequently in cancer of the stomach, in gastric ulcer, in congestion of the stomach, in liver disease, and in peritonitis; their occurrence toward the end of a prolonged labor may likewise be mentioned here as a somewhat serious symptom.

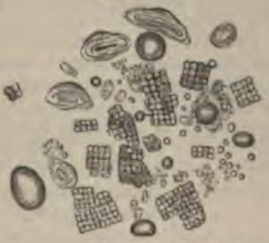
Bile in the vomited matters is often complained of when the presence of the altered blood just referred to is really meant. Bile is to be recognized as a greenish or yellowish viscid fluid; it is usually yellow at first but green in the later stages of protracted vomiting: it may be vomited up in any case where the retching and straining are prolonged, after the stomach has been emptied of its contents.

Pus is rarely vomited from the stomach, although very frequently brought up from the lungs. Occasionally submucous suppuration of the stomach, stricture of the œsophagus, or of the cardiac orifice of the stomach, and the opening of an abscess into the stomach, may give rise to this symptom.

The appearance of worms and of shreds of hydatids is important: the round worm (ascaris lumbricoides) is the only one commonly met with in such a way. It is occasionally vomited by children during illnesses of various kinds not directly related to the presence of worms.

The microscopic examination of the vomited matters reveals muscular fibres, starch granules, oil globules, and shreds of vegetable tissue, according to the diet of the patient. Crystals of margarine, etc., are also often seen. Blood, pus, etc., may be recognized, if their structure be not destroyed by the digestive fluids. "Cancer cells" can seldom or never be recognized as such with any degree of certainty. The growth known as *Torula cerevisiæ*, or the yeast plant, is often found in fermenting matter from the stomach. (See Fig. 86, Chapter XII.) *Sarcinæ* should likewise be searched for when there is fermentation, or in cases of accumulation of the contents of the stomach. (See Fig. 60.) They are found in many cases of dilatation of this organ, from whatever cause, in ulcer and cancer of the stomach without dilatation, and in certain cases of gastric catarrh. Their presence or absence cannot be relied on in the differential diagnosis of these affections. These are little square structures resembling wool-packs, from which they take their name. When found in the stomach or its contents they are called *Sarcinæ ventriculi*, but similar structures have been found in the urine (see Chapter XIII.), and in various other fluids of the body. Digestion of the vomited matter in liquor potassæ brings out the appearance of the sarcinæ somewhat more distinctly.

FIG. 60.



Sarcinæ ventriculi, with starch granules, and oil globules, from vomited matters. (Otto Funke.)

For the appearance of hooklets, etc., from hydatids, see Fig. 72. Casts of the gastric follicles have been described by Dr. Fenwick as occurring in vomited matters.

Eructations and *regurgitation* of food or fluids are to be considered as to the time at which they occur with regard to meals. A slight amount of regurgitation of milk, after sucking, is quite natural in infants. In adults, regurgitation may occur during the process of digestion; in such cases it is usually accompanied with pain and excessive acidity ("heartburn"). There may be a rising of fluid into the mouth, however, without acidity; indeed, the fluid which thus ascends from the stomach or œsophagus may be quite bland or even alkaline; such "waterbrash" (pyrosis) is always an indication of digestive disorder, and occasionally of serious lesions of the stomach. Apart from the ascent of actual fluid from the stomach, the patient may be conscious of excessive acidity, and the gas belched up may be recognized as very sour. At times the eructations have the sharp smell of rancid butter (butyric acid fermentation); at other times there is the smell of sulphuretted hydrogen; sometimes the gas is inodorous, and, as a rarity, it has been found inflammable. Occasionally œsophageal vomiting resembles regurgitation from its occurring just after attempting to take food, although this has not really entered the stomach.

FLATULENCE AND HICCUP.

Flatulence manifests itself by distention in the region of the stomach and bowels, causing often a certain amount of pain and discomfort in these situations, relieved to some extent by the passage of wind from the mouth or from the anus. Rumbling noises and colicky pains often attend the passage of wind along the intestinal tract. But, in addition to these more obvious symptoms, wind in the stomach often gives rise to pain between the shoulders, or about the heart, to giddiness, faintness for a minute or two, palpitations of the heart, etc.

The period in the process of digestion at which the flatulence begins to appear should be ascertained, as also the influence which certain articles have in determining the flatulence (vegetables, saccharine, starchy and fatty foods, tea, tobacco, alcohol, etc.). The peculiar fermentation which leads to the production of gas may be often guessed at by the description which the patient gives of the taste and smell of the eructations, or perhaps it may be judged of by the observer. The lactic acid, the butyric acid, and the alcoholic fermentations are the commonest. The gas is sometimes quite inodorous, and it occasionally appears so soon after the taking of food that it can scarcely have had time to result from fermentation. At other times a dilated stomach with visible peristaltic movement may be filled with fermenting matters, and the gas brought up may have a beery smell.

The repeated passage of wind from the bowel in cases of intestinal obstruction serves to show that the obstruction is not absolute. The suppression of the passage of wind leads in cases of this class to excessive tympanitic distention of the abdomen, especially if the seat of obstruction be low down, so as to lead to distention of the colon.

In addition to intestinal obstruction, the accumulation of wind in the bowels is commonly observed in peritonitis, both acute and chronic (puerperal, traumatic, and tubercular, as well as other forms). In enteric fever, a certain degree of this "tympanites" is habitual, and in adynamic states in this and other diseases it often assumes alarming characters. In disease of the liver, and in ascites resulting from that or other causes, such flatulent distention is most distressing and often seems to the patient the essence of the disease. In rickets, and in some forms of infantile disease characterized by digestive derangement, distention of the bowels is so habitual as to lead to a permanent enlargement of the belly, sometimes simulating more serious disease.

In cardiac disease the digestive functions are often impaired, probably from passive congestion, and distressing flatulence in the stomach from this or from nervous causes may be the result: this fact is all the more important as flatulence very often gives rise to symptoms simulating heart disease, such as fluttering, irregularity, oppression, and breathlessness, and so these symptoms may be misinterpreted. Flatulence in the stomach and bowels is one of the commonest features in cases of hysteria. A sensation compared to the ascent of a ball of wind to the throat, producing a sense of impending suffocation, is often described by hysterical patients (globus hystericus).

Hiccup is common as appearing readily in certain persons after eating or drinking; when of short duration it is seldom of much importance. Protracted duration of hiccup is always a serious symptom, especially in fevers or other illnesses with much nervous prostration, in diseases of the liver and kidneys, and in cases of intestinal obstruction.

STATE OF THE BOWELS—ABDOMINAL PAIN.

The state of the bowels requires to be noted in most cases. In healthy subjects the bowels act about once in the twenty-four hours: certain persons have two motions in the day, or a motion only once in two days, without any real departure from health. In children the motions are, as a rule, more frequent than in adults, and in young infants three or four motions in the twenty-four hours may be regarded as normal. In judging of the *frequency or infrequency of the motions*, as an index of disease, we must have regard to the quantity and quality of the food used, and the amount of muscular exercise. Scanty food, or the use of food that can be nearly all absorbed without residue, and the absence of active exercise, tend to produce scanty and infrequent motions. Constipation, prolonged beyond three or four days, must be regarded as an abnormal state: occasionally, however, there is an interval of nearly a week between the motions in persons who reckon this their natural condition. The frequency of the motions should be stated, if possible, as to the actual number of stools in the twenty-four hours: occasionally, it is important to know whether the frequency is less during night, and then the number of stools by day and by night may be given separately. Sometimes two or three motions occur so close together as to make it almost fair to reckon them one motion, particularly if no frequency exists at other parts of the day. The influence of certain meals may often be seen in determining several motions at particular times, as immediately on beginning breakfast, although there may be no disturbance afterward. In children the relation to taking food is often so marked as to give rise to the erroneous idea of the milk just swallowed having passed at once through the bowels. The influence of movement and exertion may sometimes be traced in the same way; the relative frequency of the stools at particular times, and under particular circumstances, has often to be specially noted, in order to give us a true idea of the state of the case.

The consistency of the motions is the next point of importance; it has a distinct bearing on the question of frequency, but this subject naturally falls to the section on the character of the stools (p. 413).

The degree of force or straining during defecation, the presence of pain in the bowels (see next section), the force with which the motions are expelled, the passage of wind with the motions, and the presence of faintness or sickness before, during, or after defecation, are all points which should be inquired into, particularly in cases of diarrhœa and constipation, and of partial obstruction of the bowel. Straining is of two kinds: the one where dry, hard feces have to be forced onward by great muscular effort, or where mechanical obstruction in the bowel, in any part of its course, leads the patient to feel as if this were required; the other form consists of a feeling as if something more were just about to pass at the anus, even when nothing or only a little bloody slime may be present: this last variety is termed "tenesmus."

When motions are passed in bed and without notice, it should be ascertained whether this arises from unconsciousness, from defective sensibility in the parts, from paralysis of the sphincters, from great fluidity of the motions, from spasmodic or irregular action of the bowel, from inability of the patient arising from pain or paralysis to effect the necessary movements, from idiocy or defective intelligence, from indifference, or, in children, from shyness or want of training. The intentional or wilful soiling of the bed, so as to mislead or to secure attention, should also be remembered as an occasional occurrence. (Compare p. 229.)

Pain in the Abdomen and Bowel.—Pain in the region of the bowels is of such importance that we must try to discriminate the different forms, and, as we cannot say at once whether the pain is in the bowels themselves, or in adjacent organs, we must consider them together.

Abdominal tenderness may be general or local, and all degrees of tenderness to the touch are met with. Generalized tenderness is found in peritonitis, sometimes to an extreme degree, so that the least touch, or even the pressure of the bedclothes is painful; the most extensive peritonitis, however, may exist with but little tenderness; and in certain puerperal cases, and in the chronic forms of peritonitis the tenderness is often extremely slight, or even altogether absent. Apart from wounds and other injuries, surgical operations, and childbirth, we find acute peritonitis to arise most frequently, perhaps, from perforation of the stomach and bowels, in the course of gastric and intestinal ulcers, enteric fever, and affections of the cæcum and vermiform appendix. Abscesses and accumulations of various kinds may, by rupture, produce the same effect (hepatic and renal abscess, severe intestinal obstruction, hydatids, ovarian cysts, vertebral abscess, rupture of gall-bladder, ulceration of gall-duct). Tubercular deposits, although commonly associated with chronic peritonitis, sometimes set up an *acute* attack. The previous history, the mode of onset, and the other concurrent symptoms must here guide the diagnosis.

Sometimes, however, peritonitis arises without any obvious cause (so-called idiopathic). Certain cases of rheumatism affecting the abdominal walls are not easily separable from peritonitis, as tenderness, fever, and vomiting may all be present. In many cases of hysteria there is extreme sensitiveness and shrinking on touching the abdomen: the absence of pyrexia in such cases usually serves to negative the idea of acute inflammation.

Localized tenderness, from circumscribed peritonitis, is found particularly over the cæcum (perityphlitis), and in the neighborhood of the uterus (perimetritis, pelvi-peritonitis, etc.). Occasionally a localized peritonitis, particularly over the liver, is found associated with Bright's disease, syphilis, and other depraved states; and a localized peritonitis is said to be sometimes produced by embolic lesions in the spleen. A peritonitis beginning as a localized or circumscribed affection may suddenly become general.

Localized tenderness, however, may likewise be due to various affections of the abdominal organs themselves apart from peritonitis: we aim at determining the site of the tenderness in relation to the organs, and at discovering any alterations in the size, position, shape, or density of the viscera in question. (Congestion and cancer of the liver, cancer, inflammation, or ulceration of the stomach, dilatation of the gall-bladder, calculous affections of the liver and kidneys, inflammations, dilatations, and displacements of the kidneys, disease of the suprarenal capsules, inflammations of the ovaries, uterus, or bladder, and aortic or other forms of abdominal aneurisms, may be mentioned in this connection.)

Colic—spasmodic and painful contraction of the bowel—often produces pain quite as great as that of peritonitis: the parts, however, are seldom very tender; pressure, indeed, may relieve the pain: the temperature, moreover, is usually natural. In severe persistent colic, associated with constipation, the question of lead poisoning should be considered. In an attack of abdominal pain, with constipation and vomiting, even when no local tenderness or tumor is complained of, the hernial regions should be carefully examined, at least, in patients of whose history we are ignorant, and the question of hernia, internal strangulation, invagination, etc., must be considered before resorting to energetic cathartics.

Abdominal pains, apart from any evidence of peritonitis, intestinal obstruction, or inflammations of the viscera, sometimes occur in such a form as to lead to the diagnosis of abdominal neuralgia, but this must always be accepted with the greatest reserve. Affections of the mesenteric glands (tubercular and malignant) are often associated with severe pain of obscure origin, and old adhesions of the intestines may give rise to pain appearing at particular times in connection probably with the varying position of the bowel, without any recent inflammation. Neuralgic pains referred to the region of the groin are often due to uterine disorders. In chronic peritonitis the pain varies much in severity; there may be extensive disease of this kind without any remarkable pain or tenderness having ever been noticed by the patient; variations in the severity of the pains in such cases depend probably, in part, on the dragging of adhesions, as just described, occurring particularly in connection with vomiting, with the movements of the bowels, distention of the intestines, etc.; fresh attacks of acute inflammation, supervening in chronic peritonitis, may sometimes be recognized by the pains being associated with a special local tenderness, and with an elevation of the general temperature.

Abscesses and tumors, especially aneurisms of the aorta, and malignant disease of the abdominal organs, or affections of the bones, often cause severe abdominal pains during the early stages at which their existence cannot be recognized by the most careful physical examination.

Pains associated with defecation are of various kinds. When there is only slight pain just before the bowels act, passing away soon after the motion, it is of but little consequence: this is very common, especially in all forms of looseness of the bowels, and in connection with the action of many purgatives. When the pains are more severe, of a griping character, and frequently recurring, considerable importance is to be attached to them. Looseness of the bowels with such pains often proceeds from the irritation set up by improper or undigested food, fruit, etc.; in dysenteric diarrhœa and dysentery, the pains accompanying defecation are, as a rule, of a more straining character, and the sense of the bowel not being properly relieved is usually very marked (tenesmus).

Painful defecation, with constipation, is commonly due to the size and hardness of the fecal masses being such as to give rise to pain from this alone; the masses are sometimes so hard or so large, and the rectum so much paralyzed, that even painful forcing with the abdominal muscles fails to dislodge the feces, and they have to be softened by enemata, or even scooped out mechanically. With hard masses of this description any tender parts of the rectum and anus are apt to be rendered exquisitely painful. Inflamed piles, fissures of the anus, prolapse of the rectum, fistula, and various forms of stricture, inflammation, ulceration, or excoriation of the parts may be mentioned as common causes of exquisitely painful defecation; a careful examination of the parts is often necessary to avoid serious mistakes.

Appearance of Motions.—The motions should be examined as to several points; the most important of these will now be considered.

Consistency: we ascertain whether the motions are "formed"—that is, possess the cylindrical shape of the bowel; the diameter of the pieces of fecal matter is of importance in the diagnosis of stricture of the lower bowel, as in certain cases they are found to be very narrow, or perhaps flattened and ribband-like. Somewhat globular masses of various sizes, usually hard and dry (scybala), are often found in cases of constipation; such pieces have lost much of the moisture and gas naturally contained in feces, from their being long retained in the pouches of the large bowel. Feces long retained often fail to float in water, on account of this loss of gas. If the motion be not "formed," it should be described as to whether it has the consistence of a thick or a thin pultaceous mass, or whether it is chiefly fluid, with a few solid masses interspersed. Fluid motions are often described as resembling "pea soup" (enteric fever); "rice water" (cholera); or the "scrapings of meat" (dysentery); etc.

The color of the motions is sometimes described simply by the terms dark, light, green, black, etc. Occasionally it is indicated by reference to the cause of the color; thus we speak of much bile or little bile being present. The natural color of the motions is derived from the biliary coloring matter; whitish or "clay-like" motions are found when there is an absence or a diminution of bile.

Blood—Melæna.—Black motions from altered blood are found when blood is mixed with the motions in such proportions and at such parts of the digestive tract as to be acted on by the gastric and intestinal secretions, as in gastric and intestinal ulceration, and some forms of hemorrhage from portal obstruction. When the hemorrhage is large, from whatever cause this may arise, the blood preserves much more of its usual color. When the bleeding is from piles, fistula, polypus, and cancer of the rectum, or from other lesions of the lower bowel, the blood in the motions usually retains its typical appearance as blood, with more or less of a florid color.

Black motions are not at once to be presumed to derive their color from altered blood, as various medicines render the motions dark, particularly iron, bismuth, and charcoal, and, to a less extent, lead, copper, tannic acid, logwood, and some others; as logwood stains babies' napkins, attention is sometimes called to this peculiarity. Mercurial purgatives often render the motions darker, but this is partly owing, no doubt, to their being thus rendered more bilious. Motions with what looks like unmixed and unaltered bile (a greenish, yellowish, glairy fluid) are occasionally seen.

Green motions are common in infantile diarrhœa; they may persist for a considerable time after the diarrhœa has been checked; motions passed with a yellow color sometimes change their appearance, so that napkins with yellow motions originally may be green after the lapse of some hours when produced by the nurse for inspection. Sometimes the motions are almost *white*, not unlike boiled bread and milk. In children the motions often present a white *curdy* appearance and possess a sourish smell, and not unfrequently undigested masses of curdled milk are found mixed up with the feculent matter.

Mucus is passed in large quantity in some cases of invagination of the bowel—large quantities of glairy, clear, gum-like material coming away with little or no fecal matter. Such mucus may be colored with a little blood, or associated with large quantities of it. Mucus, usually of a less transparent kind, is found more or less in cases of dysentery, and in such cases a little bloody mucus may constitute the whole of a motion, voided with a feeling of great urgency, and passed with much pain and straining. Other forms of mucous discharge, consisting of more opaque yellowish flakes and shreds, are passed in cases of catarrh of the bowel, and considerable casts of parts of the intestinal tract are voided in certain cases of so-called "mucous disease."

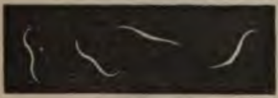
Shreds of mucus are often spoken of by patients as "skins," and are sometimes confounded by them with portions of disintegrated worms.

Pus in the motions may proceed from various affections of the lower bowel just named in connection with bleeding from the same situation (see p. 413), and some admixture of pus is common in dysenteric motions and in the affection referred to as intestinal catarrh. Inflammations of the cæcum sometimes result in the discharge of pus from the bowels.

Various abscesses open into the bowel, and may thus give a whitish coating to the feces, or furnish a considerable quantity of pus. Of these the most common are pelvic abscesses, connected with childbirth, or affections of the womb; but abscesses arising from the kidney and other organs in the abdomen, and even psoas abscesses, occasionally burst into the bowel. Abscess of the prostate usually opens in this way. Sometimes a cancerous tumor breaking down presents something like a purulent deposit in the feces. Portions of bowel which have sloughed may also be voided with the motions, usually, however, in a gangrenous or disintegrated state. This occurs in certain cases of recovery from invagination of the bowel.

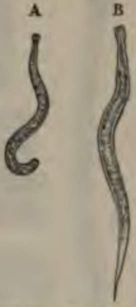
Worms are usually seen quite readily if the motions are examined at all, at least in the case of round worms (*ascaris lumbricoides*), and tapeworms (*tæniæ* of various kinds). Thread worms (*oxyurides*), however, require to be looked for more closely as they are small. Their movements, when expelled alive, assist in their recognition. (See Figs. 61 and 62.) The mere statement of patients as to the presence of worms should be received with caution; they must be made to describe the appearances seen, and, if possible, fragments of tapeworms should be brought for examination, and directions should be given for the narrow parts to be specially looked for and preserved for scrutiny, to see if the head of the parasite is included in the mass.

FIG. 61.



Oxyurides vermiculares. Female, natural size. (After Davaine.)

FIG. 62.



Oxyurides vermiculares, magnified five times. A. Male; B. Female. (Leuckart.)

The different kinds of *tænia* may be recognized by the appearance of the head, and by the microscopic examination of the proglottides with regard to the arrangement of the passages in the uterus, with the ova, etc. For this purpose one or two of the large segments are placed on a microscopic slide to dry (after immersion in strong spirit) so as to be rendered transparent. The *tænia solium* and the *tænia mediocanellata* are the only tapeworms common in this country. (See Figs. 63–67.) *Bothriocephalus latus* is another variety of tapeworm, characterized by the presence of two deep depressions—one on each side of the head—instead of the suckers as in those figured here.

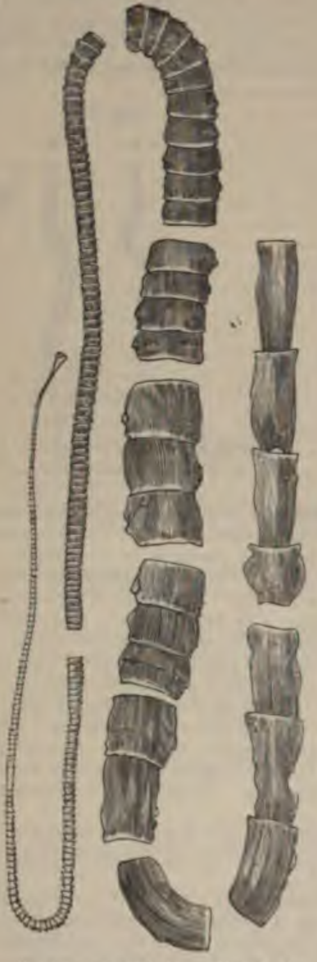
Round worms resemble earth-worms in general appearance, although paler in color. The female worm is usually about the length of the page of this book, and the male is considerably smaller (400 mm. and 250 mm. respectively *as a maximum*). When dry, however, they shrivel up to some extent.

Portions of hydatids are sometimes expelled with the motions. Any little cysts resembling these should be preserved for further examination. (See Fig. 72, Chapter XII.)

Fatty matter is occasionally found in the motions in large quantity; it has been noticed in certain cases of disease of the pancreas. Smaller quantities of oily material may be passed from the inability of the patient to digest or absorb the fat in the food or the oil administered as medicine.

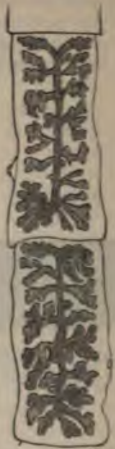
Gall-stones must be searched for in the way described elsewhere (see "Jaundice," p. 427) when the discovery of them is important. We must accept the statement of patients as to passing gall-stones with great reserve, unless they can be produced, or unless they have

FIG. 63.



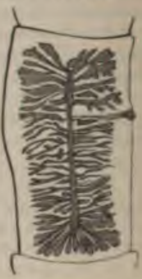
Tænia mediocanellata, natural size, showing the different size and shape of the segments in the various parts. (The *tænia solium* resembles this in general appearance; for distinctions see Figs. 64–67.) (Leuckart.)

FIG. 64.



Proglottides of the *tænia solium*, magnified twice, showing arrangement of the uterus. (Leuckart.)

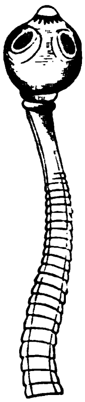
FIG. 65.



Proglottis of *tænia mediocanellata*, magnified, showing the arrangement of the uterus (Leuckart.)

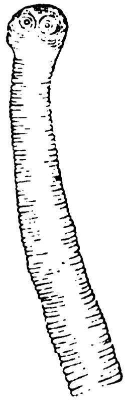
been found in the way described, as hardened feces and intestinal concretions are sometimes mistaken for them.

FIG. 66.



Head of *tænia solium*, armed with a circle of hooklets, showing two of the four suckers. (Dr. Cobbold.)

FIG. 67.



Head of *tænia mediocanellata* (not armed with hooklets), showing two of the four suckers. (Drawn by Dr. John Wilson.)

Bones, *coins*, *artificial teeth*, and various other things, swallowed by accident, are often found in the motions after very variable periods, extending sometimes to several months, after the accident. Such articles are often more or less corroded by the digestive fluids; any animal matters in the article are usually greatly diminished in bulk, or even quite absent. The metallic parts acted on may have caused discoloration of the motions during the period the article was retained.

The smell of the stools is sometimes particularly offensive, and special odors can sometimes be recognized as peculiar to certain conditions, but they are not easily described. Amongst the most offensive are dysenteric motions, and the motions in certain forms and stages of enteric fever. In the diarrhœa of children the milk sometimes undergoes a peculiarly offensive decomposition, controlled in certain cases by the previous boiling of the milk. In jaundice also the motions are often very disgusting, and in some cases of gastric and biliary derangement. Sourness can often be recognized as characterizing the motions of children, and such motions are often distinctly curdy. The odor of sulphuretted hydrogen, present in natural feces to a variable extent according to the nature of the food, is extremely marked during the internal use of sulphur and some of its compounds. Other medicines may also communicate their special odor to the stools.

The clinical significance of constipation and diarrhœa varies extremely. Slight indications have been inserted in enumerating the different symptoms, and the following hints are now added.

Constipation is extremely common in its slighter forms, in connection with disorders of digestion, especially such as proceed from nervous causes, worry of business, irregularity in habits, etc. But similar causes lead in some subjects to diarrhœa. Alternations of constipation and diarrhœa are common in certain forms of gastro-intestinal disorder, and are met with even in dysentery and enteric fever. Occasionally also the constipation usual in cancerous obstruction of the rectum is varied by an intercurrent profuse diarrhœa. A constipated state of the bowels is habitual at the beginning of many febrile disorders. Pretty obstinate constipation is so frequent at the beginning of meningitis as to afford an important indication of its onset. Occasionally a preëxisting diarrhœa is replaced by constipation on the supervention of meningitis. Constipation when protracted, especially when associated with vomiting or hiccup, and abdominal pain and swelling, should always dictate the necessity of examining for hernial strangulation, even in the less usual situations, or for considering the question of internal obstruction in its various forms, or of invagination of the bowel. The occurrence of visible peristalsis, and loud rumbling or gurgling noises, indicate mechanical obstruction: in such cases an examination of the rectum by the finger is usually called for in the diagnosis. Chronic peritonitis sometimes leads to similar symptoms. Paralysis of spinal origin occasionally gives rise to constipation of such an obstinate character as to suggest the idea of obstruction.

Diarrhœa attends certain febrile states, apart from any specific intestinal affection, being induced in some way by the pyrexial state, or the poisoned condition of the blood, and perhaps by the inability of the patient to digest the food taken in, especially if overfed with rich animal soups. Even in healthy subjects, indigestible or undigested food gives rise to looseness of the bowels, usually associated with griping pains. Poisonous substances often produce severe diarrhœa. In addition to the well-known cathartics and the irritant poisons, certain forms of shell-fish and the flesh of animals in certain states of decomposition may be mentioned, and special changes from the preparation of the food, occurring at times in sausages, pies, etc. The influence of impure water, the leaking of sewage pipes, the emanations from foul drains, and the climatic and other influences which lead to dysentery may be mentioned in this connection. Cholera in its epidemic form, and in the less severe forms known as British or autumnal cholera, and cholera infantum, may likewise be referred to in this group. The scarlatinal poison sometimes manifests its early presence by a violent diarrhœa, especially in malignant cases; measles also is liable to this complication. The spontaneous looseness seen in certain stages of uræmia and in puerperal fever may be referred to a similar cause. Enteric fever (with its intestinal lesion) presents an intermediate form between the foregoing and those cases of diarrhœa which owe their origin to local causes, as tubercular, catarrhal, or dysenteric ulceration of the bowels. Peritonitis frequently gives rise to severe forms of diarrhœa; but in many other cases there is constipation.

The presence or absence of the various concomitant symptoms, and the results of the physical exploration of the abdomen, must be relied on for the differentiation of these forms.

The Teeth and Gums.

An examination of the teeth affords evidence in many cases of certain constitutional states, as well as of various local sources of disturbance. The number of teeth differs in the first and the second dentition. The age of young persons can sometimes be estimated from the state of the dental development.

FORMULA OF THE MILK TEETH.

$$\left.\frac{M_2\ C_1\ I_4\ C_1\ M_2}{M_2\ C_1\ I_4\ C_1\ M_2}\right\}\text{20 in all.}$$

The order of their appearance varies somewhat. As a rule, the lower central incisors appear first, then the upper central incisors, and then the lower lateral incisors. The following may be given as the usual order and date of their appearance:

Central incisors,	about the	7th	month.
Lateral incisors,	"	9th	"
First molars,	"	15th	"
Canines,	"	18th	"
Second molars,	"	24th	"

The order, however, is sometimes different; the date of the appearance is sometimes earlier, and often much later than appears above. The process goes on by little starts, with distinct intervals or pauses between.

Disorders of Dentition.—Lateness in dentition often arises from the constitutional derangement known as rickets; the disturbances of digestion, and of the general health, arising from this cause, are often ascribed erroneously to the ills of teething. But although the first teeth have appeared at the usual time the rickety state may really exist, and from this cause, or from the occurrence of attacks of illness, the normal progress of the dentition may be arrested or delayed for a time. Precocious cutting of the early teeth is often followed by delays in the subsequent ones.

During the process of teething the infant has usually a great increase in the amount of the saliva. Various disturbances of the health, especially diarrhœa, cutaneous eruptions, and convulsions, are ascribed by the public to this process, particularly when the dentition is delayed or irregular in its course; but these illnesses are often due to disorders produced by the use of artificial food which is frequently begun at the teething time; or they may be due to rickets or to some other vice in the constitution of the infant. The advance of the teeth is characterized at times by great tenderness over the gums; in other cases the rubbing or squeezing of the gums seems to afford relief or satisfaction. The prominence of the gum over an advancing tooth often gives quite a fallacious idea of its nearness to the surface. Such appearances may come and go more than once before the tooth comes through. We can seldom safely predict the speedy cutting of a tooth unless the sharp edge be felt just under the gum. Any unusual heat of the mouth, any increase in the salivation, and any little ulcerations of the gums should be noticed in connection with the teething process.

In bad forms of rickets and syphilis the teeth may never appear at all, and in other cases the milk teeth often rot away or drop out prematurely. This loss also happens occasionally in other cases, from gastric disorders. Various medicines are sometimes blamed for destroying the teeth (mercury, iron).

The second dentition begins with the appearance of the *first permanent molars;* this precedes the shedding of the twenty milk teeth, which begin then to fall out in succession.

FORMULA OF THE PERMANENT TEETH.

$$\left.\frac{M_3\ B_2\ C_1\ I_4\ C_1\ B_2\ M_3}{M_3\ B_2\ C_1\ I_4\ C_1\ B_2\ M_3}\right\}\text{ 32 in all.}$$

The order in which they make their appearance may be thus stated:

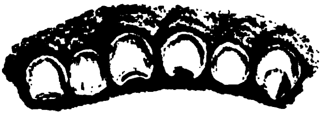
Anterior molars,	at the 7th year.
Central incisors,	" 8th "
Lateral incisors,	" 9th "
Anterior bicuspids,	" 10th "
Posterior bicuspids,	" 11th "
Canines,	" 12th "
Second molars,	" 12th to 14th year.
Third molars,	" 18th to 25th "

The eruption of the permanent teeth seldom gives rise to much local or constitutional disturbance, except in the case of the "wisdom teeth;" considerable pain and swelling sometimes appear in connection with the cutting of the last molars, in the lower jaw in particular.

The shape and appearance of the teeth sometimes afford important indications. Transverse grooves and slight pitting on their surface are supposed by some to indicate a scrofulous constitution, or at least the occurrence of some previous derangement in the health.

The notched teeth described by Hutchinson afford important evidence of congenital syphilis. They often occur in those affected with syphilitic keratitis or with nervous deafness and other manifestations of the inherited disease. The deformity affects the upper central incisors most frequently and most distinctly, although the other incisors and the canines may also be affected. The upper central incisors, in a typical case, are dwarfed both in their length and breadth; the atrophy affects the middle lobe, giving rise to a central notch at its edge; sometimes from this notch there may be traced a shallow groove both before and behind. These changes are not always present in hereditary syphilis; they are only of value as signs in the case of the *permanent teeth.* After a time the depth of the notch may be lessened through the wearing down of the edge, but the deformity can usually be detected even then. (See Fig. 68.)

FIG. 68.



Notched teeth. Malformation of permanent teeth found in hereditary syphilis. (Mr. Jonathan Hutchinson.)

Caries of the teeth occurs from causes not fully known, but the lingering of acescent fluids about the teeth, arising from the decomposition of particles of food in the mouth, seems to favor this destruction. Caries is frequent in cases of chronic dyspepsia. This affection of the teeth sometimes accounts for the fetor of the breath which may be noticed; this might be erroneously ascribed to disorder of the stomach, etc. The condition of the teeth has important bearings, likewise, on the diagnosis of facial neuralgia, pains in the ears, affections of the eyes, etc.; the pain sometimes radiates from the teeth, not only all over the face, but even down to the neck. For a proper examination of the teeth in this respect the assistance of the dentist is often essential, but in the absence of this we may learn something from detecting some special tooth, obviously rotten, or with an exposed pulp, which gives rise to sharp pain on pressing it or probing it. In a diffused facial neuralgia, from any cause, we must remember that the teeth also may participate in the general suffering, so that we must search for a local and specialized tenderness of one or two teeth in particular. Neuralgia seems sometimes to be set up by the extraction of a tooth—the pain being recognized by the patient as different from that of the previous caries.

The rottenness or the absence of the teeth may throw important light on dyspeptic disorders, or even on the imperfect nutrition of a patient. Defects in the teeth often seriously prevent the due trituration of the food necessary for its proper digestion and assimilation.

Falling out of the teeth occurs in connection with mercurial salivation,and also in connection with scurvy. The earliest signs of these affections, however, appear in the gums. The teeth also fall out in certain cases of destructive ulceration involving the gums (noma). The milk teeth often rot and fall out prematurely in rickets and syphilis.

Grinding the teeth is almost habitual in certain children, and it readily occurs in others when the stomach and digestion are out of order. Its presence, therefore, is not to be ascribed at once to the irritation of worms, although this is a prevalent popular opinion. No doubt, however, it is frequently present in such cases. In smallpox and some other febrile diseases in childhood grinding of the teeth is an unfavorable indication. Although commonest in childhood this symptom is not unknown in adults.

The gums are often spongy and their edges ragged and irregular in those whose teeth are bad and neglected, and when the tartar is very abundant. When these causes of irritation exist the indications from the gums are not so valuable.

Swelling of the gums, with slight tenderness, constitutes one of the earliest indications of the action of mercury. The special fetor of the breath due to mercury and the occurrence of salivation also help the diagnosis. This influence is produced whatever may be the way in which the metal enters the system. Some other metallic poisons cause something of the same kind, but in a much less degree.

The blue or blackish line involving the gums, just beyond the teeth, affords, when it is pronounced, a valuable indication of lead poisoning. When it is present we must inquire for the history of colic, and the other signs of poisoning, and ascertain if any exposure to the deleterious influence of lead has arisen in connection with the water supply or the occupation of the patient.

A red line on the gums is regarded by some as an indication of a phthisical constitution: although often present, no great reliance can be placed on its indications.

Very spongy gums, with submucous hemorrhages, are common in scurvy; bleeding readily arises from slight irritation of the parts, and fetor of the breath is also usually present. Slight forms of scurvy are not uncommon among laborers who carry their food to their work, and live on tea, bread and bacon, etc. Subcutaneous hemorrhages, etc., must be looked for. Purpura likewise affects the gums, but they are seldom so spongy as in scurvy, and hemorrhages sometimes arise there; these may prove serious from their persistence and the difficulty of stopping the bleeding.

Inflammation of the gums may form part of a general affection of the mouth, already described (vesicular, ulcerative, and gangrenous stomatitis; see p. 399). The local inflammation or swelling known as "gum-boil" arises from inflammation around the root of the tooth affected (periodontitis): the tooth is often felt to be tender, and sometimes to be elevated, as it were, from the socket. The local disturbance, as manifested by swelling, and the general inflammatory reaction are often extreme: when by accident the swelling is not considerable the first indication of the cause of the violent symptoms may be the appearance of pus by the side of the tooth. With inflammation of the gums from any cause more or less salivation is frequent.

The presence of sordes on the gums and teeth in fevers, of the white patches of muguet, and the discoloration of Addison's disease, have been noticed elsewhere. (See pp. 142, 397, 398.) Pallor of the gums affords a valuable indication of anæmia.

General treatises on medicine and special works on diseases of childhood deal with many of the subjects referred to in this chapter. For details as to disorders of the rectum, anus, etc., reference must be made to surgical works. See also references in Chapter XII. on "Jaundice," and Chapter XVI., part 3, on the "Examination of the Abdomen."—Wilson Fox, Diseases of the Stomach, 3d edition, London, 1872.—Pavy (F. W.), Practical Treatise on the Function of Digestion; its Disorders and their Treatment, 2d edition, London, 1869.—Habershon (S. O.), On the Diseases of the Stomach; the Varieties of Dyspepsia, their Diagnosis and Treatment, 3d edition, London, 1879: also Pathological and Practical Observations on Diseases of the Abdomen, 3d edition, London, 1878.—Chambers (T. K.), The Indigestions, London, 1867.—Germain Sée, Des dyspepsies gastro-intestinales, Paris, 1881.—Brinton (Wm.), Intestinal Obstruction, London, 1867.—Treves, Intestinal Obstruction, London, 1884.

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CHAPTER XII.

JAUNDICE AND DROPSY.

It is convenient to consider these affections together, as both are frequently due to disease of the liver, and it is not uncommon to find both in the same patient. It must be remembered, however, that dropsy arises from various causes, and may depend on diseases which have no connection with jaundice or with any form of hepatic disease.

JAUNDICE.

When jaundice is well marked there can be no mistake about its presence. The yellowness of the skin and ocular conjunctiva, and the discoloration of the urine with bile, present a striking and easily recognized group of symptoms. Discoloration of the skin, somewhat resembling jaundice, is found in certain cases of anæmia, in chlorosis, in Addison's disease, and in the chloasma associated with fibroid tumors and other affections of the womb. Exposure to the sun and weather may produce in certain complexions a tinge resembling jaundice, and the serious disturbances of the general health induced by intermittent fevers, by the presence of malignant disease, and by syphilis, all resemble at times, the cutaneous discoloration of jaundice. All these may usually be seen to differ from the jaundiced tint on a critical examination; and in nearly all these affections the whiteness of the conjunctivæ, which often indeed shine out with a pearly brightness, removes the cases at once from this category. The conjunctiva, however, sometimes presents a dingy yellow color, apart from jaundice, this being due to the presence of yellow subconjunctival fat, and this complication presents a serious difficulty in determining the presence or absence of a slight discoloration; but when the color is due to this cause it usually occurs in patches at special parts, and is not so evenly diffused as in jaundice.

The urine comes to our aid in such doubtful cases, for it very readily assumes the jaundiced color. The method of testing for bile pigment is described in the section on urinary examinations. (See Chapter XIII.) No great reliance can be placed on the reports of patients regarding bile in the urine, as they often mistake bloody or concentrated urine for bilious discoloration, and the internal use of santonin or rhubarb may produce a pretty close resemblance to bilious urine. The urine shows the presence of jaundice earlier than anything else, but it likewise is the first to lose the color, if the attack be passing off, so that the urine may be free from bile although the conjunctivæ still remain really tinged with it. By watching the skin, the conjunctivæ, and the urine, in different stages of the suspected jaundice, we are seldom left in much doubt. The urine in jaundice is often turbid from mucus, or it may deposit urates: even when it does not give distinct reactions on testing for albumen the sediment often contains abundance of colored tube-casts.

The appearance of the stools renders much assistance in the study of jaundice, for while everything else is discolored, the motions are often free from bile, presenting a paler appearance than natural. This is often best described by the word "clayey." But we may also have marked jaundice with much bile in the feces. The pale color of the feces may thus, in doubtful cases, assist the diagnosis of jaundice, but their bilious color does not count for much as negativing the idea of jaundice. The motions in jaundice are usually costive, and if long retained in the bowel the feces are often highly offensive, from decomposition going on within. The bile acts normally both as a purgative and an antiseptic.

OBSTRUCTIVE AND NON-OBSTRUCTIVE JAUNDICE.—The presence or absence of bile in the motions affords an important aid in classifying the cases according as they are, or are not, due to or associated with obstruction of the common bile-duct. If such obstruction be the cause of the jaundice, the motions are pale in proportion to the depth of the jaundice: we find, as a rule, that in cases due to obstruction the jaundice is much deeper than where no obstruction exists.

The obstruction may be due to something *within* the duct itself: thus thickening of the mucous membrane in the walls, or any excess of mucus, may readily give rise to the form called "catarrhal:" gall-stones may block up the channel, or the ducts themselves may be the seat of a malignant growth. Ulcers, cicatrices, foreign bodies, and even worms have been known to interfere with the opening of the duct into the duodenum, and catarrh or inflammation of the mucous membrane of the duodenum may likewise cause obstruction from the swelling implicating the orifice of the duct or from the extrusion upward of the catarrhal process.

But the obstruction may be due to pressure from *without*, by a tumor (usually malignant) in the pancreas or duodenum; or by waxy, cancerous, or scrofulous glands at the fissure of the liver; or, a tumor connected with the liver itself may, from its position, compress the duct, as in the case of a cancerous nodule, an abscess, an aneurism, or a hydatid cyst; or again, an inflammatory exudation (perihepatitis) may by its contraction constrict the duct. Abdominal tumors connected with the kidney, ovaries, etc., may compress the bile-duct and give rise to jaundice. The pregnant uterus, or fecal accumulations in the bowels may likewise do so; and hardened scybala have been mistaken for cancerous nodules in cases of jaundice due to such a cause.

In discriminating these causes we have regard to the size and form of the liver, the presence and character of the pain (if any), and the special symptoms of the various affections named, in their relation to the date of the appearance of the jaundice. In cancer the liver is usually enlarged, often nodular, more or less painful, and tender to the touch. The occurrence of jaundice is due to the accidental position, as it were, of the cancerous mass, and so it may be an early or a late symptom, and indeed it is often absent in hepatic cancer. Malignant disease elsewhere is, of course, a strong presumption in favor of the cancerous origin of jaundice. The persistence or variability of the jaundice is important; jaundice due to the pressure of a cancerous nodule on the duct never disappears after it is established; the history of previous attacks of jaundice, therefore, which have passed off, predisposes one in favor of a less serious view of the case; but we must remember that in rare cases the previous attacks may have been of quite a different nature from the existing jaundice—thus gall-stones and cancer may exist in the same case.

The *combination of intense jaundice and white stools with abdominal dropsy* at the same time may be regarded as pointing to an obstruction of the duct and of the portal vein by the same cause, which in such a case must be something *outside* of both, usually a cancerous mass. Jaundice, usually slighter in character, may exist along with dropsy due to cirrhosis of the liver; the jaundice in such cases is not only usually slight, but bile is not completely absent from the stools, unless, indeed, there be a complication from a concurrent catarrh of the ducts giving rise to obstruction; a *diminu-*

tion of the bile in the feces may, however, be found resulting from the atrophy of the cells in the liver. When there is dropsy with a congested liver, from alcohol for example, the motions may be highly bilious.

The presence or absence of pain is an important point in the study of jaundice. Pain is usually, but not always, more or less present in cancer; even in catarrhal jaundice, with perhaps some congestion of the liver, there is some pain and discomfort in the hepatic region. In the passage of gall-stones the pain reaches a maximum; it is very violent, paroxysmal, and often associated with great sickness. Such paroxysms of pain may occur several times during the attack of jaundice, as well as for a day or two before it appears. Occasionally the jaundice is permanent, the gall-stone being permanently impacted in the common bile-duct. Attacks of pain and jaundice due to the passage of gall-stones are apt to be repeated after an interval of months or years. We must remember that it is possible to have an attack of biliary colic without jaundice, from the gall-stone escaping quickly, or from its only affecting the cystic duct. The detection of gall-stones in the motions settles the diagnosis. In doubtful cases, where there is a suspicion of cancer, these must be carefully sought for. Although dried gall-stones float in water, they do not come to the surface on adding water to the feces and breaking up the solid masses as is sometimes supposed. To detect them we must pass all the motions through some form of sieve, or through a muslin filter after pounding them sufficiently with a stick, and the offensiveness of the process may be lessened by adding previously some disinfectant, such as Burnett's or Condy's fluid. If there is any doubt as to the object found being a gall-stone, a portion of it may be pounded and dissolved in sulphuric ether or boiling alcohol, from which crystals of cholesterine are deposited. (See Fig. 73.)

Rigors occurring in jaundice point to distention of the bile-ducts from the obstruction of gall-stones; or to the presence of abscess of the liver; or perhaps to the existence of pyæmia, of which the jaundice may be a symptom. Hemorrhages from the stomach and bowels, and subcutaneous blotches occur in old and severe forms of jaundice, and are due probably to deterioration of the blood in cases of obstruction, or to blood-poisoning or portal obstruction, in those serious cases where there is no obstruction of the ducts in any form. Hemorrhages from the umbilicus occur in some grave forms of infantile jaundice. (See p. 432.) In addition to the symptoms already noticed, itchiness of the skin, yellow vision, cutaneous eruptions, xanthelasma, slowness of pulse, a lowered temperature and impaired nutrition, are occasionally very noticeable. Sometimes jaundice appears without anything else to attract attention, not even squeamishness or impaired appetite. Popularly, jaundice is often ascribed to a feeling of disgust produced by disagreeable sights and smells, but probably in such cases the incipient jaundice really makes the persom more susceptible than usual.

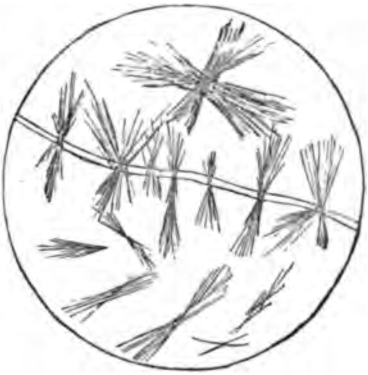
Jaundice without obstruction of the ducts is still somewhat of a puzzle both clinically and pathologically. Clinically the proof of bile in the stools is at times rendered doubtful by our knowledge that in some cases of this class there is a tendency to hemorrhage, and small quantities of blood, by imparting a dark color to the feces, may simulate an admixture with bile; some cases might thus be erroneously regarded during life as free from obstruction of the ducts owing to this misinterpretation of the color of the stools. Even pathologically the case may be misinterpreted. It is now known that very slightly increased resistance to the flow of bile through the ducts may lead to a practical obstruction and a tendency to reabsorption of the bile, but these slight impediments may be easily overcome mechanically by the pressure of the pathologist on squeezing the gall bladder; it is even possible that accidental pressure in the handling of the organs, before examining the orifice of the duct, might be sufficient to force on the bile into the duodenum although little or none could pass during life.

There is, however, a pretty general agreement that jaundice may occur, and does often occur, without obstruction. The relationship of such cases to changes in the blood has often been suggested and is no doubt full of significance. One interesting variety of this relationship is the coincidence of hæmoglobinuria with non-obstructive jaundice. We have here evidence of destructive processes going on in the red blood-corpuscles leading to their disintegration, so that they are no longer recognizable in the urine as corpuscles, although their hæmoglobin is present in abundance. In grave forms of the so-called "pernicious anæmia," we have at times a true jaundice or bile pigmentation, quite distinguishable from the mere sallow tint of the face so common in this and various other forms of anæmia. In such cases of pernicious anæmia we have profound alterations in the blood with tendencies to hemorrhages and other indications of grave disorder.

Hæmoglobinuria and jaundice of the non-obstructive variety may both be induced by poisons, and they may be both found together in the same case at the same time, as the result of poisoning of the system in bad malarial fevers, for example. As a great clinical group we may, therefore, class various poisons together as active agents in producing non-obstructive jaundice. Phosphorus, antimony, and arsenic, may be named as well-known poisons giving rise to jaundice. More doubtfully, perhaps, chloroform and ether may be admitted as occasionally doing the same. Next, we have snake-bites, whose influence in causing jaundice rapidly, without obstruction, has long been known. This animal poison forms an interesting link between the ordinary poisons and the poisons of the specific fevers. Thus, in relapsing fever, in typhus, occasionally in scarlatina, and notably in yellow fever, we may have jaundice. The so-called "epidemic jaundice" implies by its name a relationship to the infectious diseases. But we may have this form of jaundice complicating acute lobar pneumonia also, a form of disease which has such numerous points of resemblance to the fevers that many are disposed to class it with them. In pneumonia complicated with jaundice it has often been stated that the *right* lung is specially involved, but this is by no means invariably the case, and even when it is the one implicated, the disease may involve the upper lobe, so that mere contiguity of the inflammatory process to the liver has evidently but little to do with the jaundice. In acute yellow atrophy of the liver jaundice is a leading symptom; the relationship of this disease on the one hand to phosphorus poisoning, and on the other to the acute specific fevers, seems to bring it into the same great group; the student must remember, however, that the female sex and the pregnant or puerperal condition, are also closely connected with the etiology of this remarkable disease. In these cases the jaundice is not usually very intense, but it is persistent; there are febrile symptoms and often great nervous disturbance, the liver is usually diminished in bulk, but this cannot always be clearly proved by percussion during life. The detection of crystals of tyrosine in the urine sometimes aids the diagnosis; these may be found in the sediment of the urine as passed; but more commonly some preliminary evaporation or concentration is required. (See Fig. 69.)

In advanced cirrhosis (or *chronic* atrophy) of the liver, jaundice with bile in the motions may occur: in such cases we may have nervous symptoms and other evidences of a poisoning of the system. Pyæmic infection is another cause of non-obstructive jaundice readily classed with the group of poisonous influences.

FIG. 69.



Crystals of tyrosine deposited spontaneously in the urine, from a case of acute yellow atrophy of the liver. (Roberts.)

Another factor in the causation of jaundice is nervous disturbance: occasionally anxiety has determined a sudden jaundice, and the influence of the nervous system on secretion is well established.

A further group of cases of jaundice without obstruction of the ducts seems to depend on the increased secretion of bile, say in cases of congestion of the liver; or on diminished activity in the processes of oxygenation, etc., by which the bile is used up in the system; or on the diminished elimination of it, the result of prolonged habitual constipation.

In the study of such cases the detection of biliary acids in the urine was at one time regarded as a point of great importance: no reliable test for these acids can be conveniently applied to the urine in clinical work, and as yet the importance of this branch of the inquiry is not great.

Cases of jaundice essentially or originally without obstruction may readily become complicated or associated with catarrhal processes leading to obstruction of the ducts and absence of bile from the stools. Again, even in cases due to influences operating on the blood, we may have jaundice without obstruction aggravated by an obstructive jaundice due to an impediment to the flow of bile from increased viscidity, this being brought about by changes in the blood from which it is secreted. The discussion of such subjects belongs, however, to pathology rather than clinical medicine.

In infancy we have often a spurious jaundice due to mere discoloration of the skin, for a few days after birth, without any affection of the conjunctivæ: pressure of the fingers on the skin, by removing the congestion for the time, may help us in recognizing the pure or the yellow tint underlying the coloration referred to. A true jaundice occurs not unfrequently from catarrh of the ducts, and sometimes from imperfect oxidation of the blood, especially in the unfavorable surroundings of a badly ventilated lying-in hospital. A very serious form of jaundice occurs in infancy associated with an unhealthy state of the umbilicus (phlebitis, peritonitis, pyæmia). Jaundice is occasionally dependent on a congenital defect of the bile-ducts: this malformation, although rare, has been known to occur in several members of the same family, and has been supposed to be possibly due to intrauterine syphilitic perihepatitis: this defect is sometimes associated with fatal hemorrhages from the umbilicus and other parts: the jaundice appears within a few days of birth, and, even if otherwise uncomplicated, leads to atrophy and death within a few months at the furthest.

DROPSY.

Dropsy must be studied in respect of its severity, its extent and distribution, the mode of its onset, and the evidence, if any, of coexisting diseases, especially of disorders of the blood, of disease of the heart, liver, kidneys, spleen, and ovaries, or of the presence of any swellings or tumors in the abdomen or chest.

ANASARCA AND ŒDEMA.—When *general dropsy* of the whole body (general anasarca) appears somewhat suddenly, the common cause is renal disease (nephritis). In such cases, if the attack be not too sudden and extreme, the swelling is usually first noticed in the face in the morning, the patient feeling his eyelids stiff and heavy, and his friends noticing a degree of puffiness in the cheeks and around the orbits: this often disappears after moving about for a time, the swelling appearing in the feet and ankles at night: this in its turn disappears with rest in the horizontal posture—the fluid gravitating according to the position of the patient. To detect œdema in the subcutaneous cellular tissue we press firmly and steadily with the point of the finger and observe if a "pitting" or depression remains. We select, in slight cases, some part with the resistant bone beneath to bring out this pitting more easily. In extreme dropsy the loose areolar tissues of the eyelids, penis, and scrotum or vulva, become speedily distended. The testing of the urine usually shows such a case to be of renal origin; pain in the loins, sickness or vomiting, headache, and more or less shivering are common in acute cases. An extreme pallor of the complexion is often a notable feature in this form of disease. Severe renal dropsy has been known to exist without albuminuria, but this is rare; the previous history of scarlet fever, etc., may assist the diagnosis in such a case.

Œdema of the feet, and even of the face, closely resembling renal dropsy, is found at times to be due to anæmia, the altered condition of the blood predisposing to these exudations. The urine should be carefully tested more than once in such cases before deciding on the absence of kidney disease, as albumen is temporarily absent from the urine in certain renal cases, especially before breakfast. Œdema from alterations in the blood occurs in connection with chloro-anæmia, and also with the disorders incident to the "change of life." But the impoverishment of the blood from fevers, profuse hemorrhage, severe diarrhœa, etc., may also lead to œdema, especially as in such cases the organs of circulation are also usually enfeebled. Chronic disease of the liver seems also at times to lead to more or less general œdema of the anæmic type, no doubt from changes in the blood: such forms of œdema may precede by a long time the occurrence of the abdominal form of dropsy more commonly due to liver disease.

Œdema beginning at the feet, and gradually invading the legs, but keeping strictly to the lower limbs, or at least to the lower part of the body, is usually due to some mechanical impediment to the circulation, either in the limbs, in the abdominal vessels, or in the heart itself. Varicose veins, venous thrombi, aneurisms, tumors, or anything pressing on the veins of the limb, tumors in the pelvis, abdominal tumors generally (including pregnancy), glandular enlargements (scrofulous or malignant) in the neighborhood of the vena cava, and similar obstructions, may all act in this way. Nearly all the forms of cardiac disease lead to some impediment to the circulation, so that, sooner or later, œdema of the feet is apt to appear, especially when the nutrition of the muscular fibres begins to fail (valvular disease, enlarged, weak, and fatty heart). When such dropsy works its way up to the abdomen, the increasing pressure on the renal veins is apt to set up congestion of the kidneys, and this complication may cause the dropsy to assume the character of general anasarca. Allied to this œdema from mechanical impediment or feeble circulation is the swelling of the feet so often seen in the case of old people, and in many exhausting diseases, especially before death. Chronic renal disease, however, may also give rise to dropsy limited for a long time to the lower limbs.

Œdema of the upper part of the body may be but part of a general dropsy, specially appearing in the dependent parts of the trunk, or in either arm, according to the accident of position: careful observation and inquiry as to the posture of the patient immediately prior to our visit may explain the variations in such cases. Œdema limited to the chest, arms, neck, or face, points to some mechanical obstruction to the circulation within the chest, giving rise probably to pressure on the veins. Tumors in the mediastinum, especially aneurisms, cancers, and glandular swellings (lymphadenoma), must be remembered in this connection. Obstructions in the lungs, as in bad forms of emphysema, with engorgement of the right side of the heart and the veins of the neck, may also determine a swollen state of the face. For similar reasons violent paroxysms of coughing, especially in pertussis, may lead to swelling of the face resembling œdema. The discrimination of these causes must be sought for by physical signs and the other symptoms.

Localized dropsical swellings are usually due to local influences. The effect of posture has already been referred to, as well as the position of a tumor pressing on special veins. In addition to these, the existence of venous thrombosis is a fruitful source of such dropsies, and this may readily concur with depraved states of the blood and feeble or disordered circulation giving rise to a more general œdema likewise.

Another form of œdema found in young children, *affecting chiefly the dorsum of the hands and feet*, but occasionally extending to the legs also differs from that usually seen in adults in that it does not pit on pressure; the swelling is firm and the skin drawn tightly over it. This condition is met with in various wasting diseases, chiefly chronic diarrhœa, and in connection with carpo-pedal spasms: it always serves to indicate a serious derangement of the strength, but is not necessarily of fatal import: it is seldom or never associated with albuminuria, and seems to belong rather to the class of anæmic dropsies. Allied to this state, with, however, greater hardness and tightness of the skin, is the condition described by Underwood as "hide-bound," and by the French writers as "*sclérème*," or "induration of the cellular tissue," often associated with great depression of the strength, and a lowering of the general temperature.

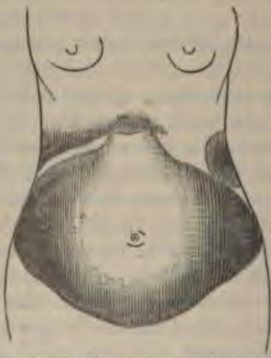
Myxœdema, a name applied to œdema of mucus- or jelly-like consistence, may closely resemble renal dropsy, particularly as the face is usually very pallid as well as dry and bloated. The swelling, however, shows little tendency to gravitate to the lower parts, and it is too firm and resilient to pit on pressure. The swelling extends to all parts of the body and often affects the sides of the neck above the clavicles, in a notable manner. The features become coarse and the hands "spade-like." The thyroid is sometimes much diminished in size. With the advance of the disease the mental operations become very slow, the whole aspect torpid, and the temper rather sullen. Toward the end of the case a regular œdema may supervene on the other swelling. The diagnosis turns on the absence of albumen from the urine, on the occurrence of this disease in adult women, and on the progressive changes in the direction already indicated.

ABDOMINAL DROPSY is of three kinds: fluid in the cellular tissue of the abdominal walls; fluid within the peritoneal cavity; fluid within some cyst in the abdomen, usually of the ovary, but occasionally of the kidney, liver, or other parts.

Œdema of the abdominal parietes is sometimes so considerable as to suggest the presence of fluid in the peritoneum, with which indeed it is often associated. It may be due to the causes producing general dropsy, as already detailed, but when it seems unduly great in this situation there is usually some local obstruction to the return of blood from the veins of this region. This œdema is discriminated from ascites by the test of "pitting," and in applying the pressure we avail ourselves of the tissues over the lower ribs, or over the ilium and sacrum, when the parietes in front yield so much as to make the demonstration difficult. This œdema changes somewhat with position, not immediately, as in the case of fluid freely movable in the peritoneum, but only after the lapse of some time.

Fluid in the peritoneum—ascites—may be of inflammatory origin (peritonitis with effusion, including tubercular, or even cancerous peritonitis); or it may be purely dropsical in its nature (hydro-peritoneum). In the former case, the fluid is sometimes partially retained in the meshes of the inflammatory exudations, or hemmed in by adhesions, so that it does not move freely with changes in the position of the patient; but, as a rule, all cases with much fluid in the peritoneum can be tested in this way, and the level of the fluid, seeking the most dependent parts, can be marked out by percussion. The intestines, unless bound down by adhesions, float up toward the umbilicus when the patient lies on his back, giving a resonant note on percussion there; but if the fluid accumulation be great, even this region may be dull, only a small area in the epigastrium yielding a clear sound. In the flanks and hypogastric region, there is often a fulness or bulging, and the percussion note is dull when the patient lies on the back, from the presence of the fluid there, as these regions are then the lowest; but if this level be marked, and the patient be turned quite round, first to the right side and then to the left, the area of dulness will be found to change completely if it be due to fluid freely movable in the peritoneum—first the one flank and then the other becoming resonant, and the dulness shifting at the same time to the parts formerly clear. Certain difficulties beset this test. Occasionally, as already stated, the fluid and the bowels may be hampered in their movements, and so the changes may be less definite. Moreover, when the amount

Fig. 70.



The shading indicates the position of the *percussion-dulness in a case of ascites*, while the patient is lying on the back, the fluid falling to the low levels in the flanks, and the umbilical region remaining clear.

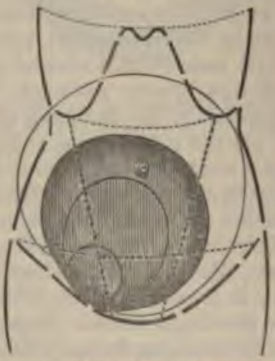
of fluid is small, we may be unable to distinguish the dulness in the flanks in the midst of the resonance from the over-distention of the abdominal wall due to the accumulation of gas in the intestines, which is so common in abdominal dropsy. Œdema of the integuments often interposes an insurmountable barrier to the detection of slight ascites. Sometimes by pressing away the œdema from a portion of the flank, or by getting the patient to lie for a long time on one side, we may be able to get quit of this complication and ascertain the state of the deeper parts. The condition of the abdominal viscera, a loaded colon, an enlarged liver or spleen; the presence of a tumor, of the gravid uterus, of an ovarian, an omental, or some other cyst, may all give an area of less movable dulness, and impair in this way the value of the test by change of posture: most of these complications usually exist only, or chiefly, on one side, and by dipping the hand down through the peritoneal fluid we can occasionally ascertain the presence of a tumor, and so make allowance for it.

When the quantity of fluid in the peritoneum is small, we can sometimes recognize its presence best by placing the patient on his elbows and knees: the umbilical region, quite resonant during examination in the recumbent posture, may then be found to give a dull note in this altered position, while the flanks formerly dull now become resonant on percussion.

Another test for ascites is the detection of fluctuation. The flat hand is placed on the side of the abdomen, and with the fingers of the other a sharp tap is directed perpendicularly to the abdominal walls on the other side, when a distinct wave is often both seen and felt. This sign varies much in distinctness in different cases. It is scarcely available except in pretty considerable dropsy. When the umbilical ring is protruded, as is usually the case in extreme ascites, this fluctuation is often well felt by placing the finger there. This sign of fluctuation may be obtained in the various forms of fluid accumulation in the abdomen, and is not limited to ascites. Even the presence of much fat in the belly may give us a certain degree of fluctuation, very likely from its almost fluid condition at the temperature of the body. An attempt is sometimes made to intercept the wave from this cause by getting some one to press the abdominal wall with the edge of the hand during the application of the test, as this is sometimes found to arrest the wave-like movement transmitted through fat in the abdominal walls. Again, when there is great flatulent distention of the intestines, with tense abdominal walls, as in many cases of rickets, a feeling closely resembling fluctuation is sometimes transmitted by the air-filled viscera, without the presence of any fluid at all. Of course, the test by percussion comes here to our aid (it may be said, however, in passing that if the bowel be *greatly distended* with air it may give a dull note: this happens occasionally in intestinal strangulation). A greatly distended bladder sometimes simulates peritoneal fluid, so that it is often wise to empty the bladder by the catheter before deciding finally on the nature of the fluid accumulation or resorting to paracentesis: in the case of women, a long flexible catheter should be used, as a silver female catheter might not pass through the elongated neck of the bladder. The mere fact of a patient having recently passed urine, does not always remove the necessity of using the catheter in doubtful cases.

Cystic dropsy of the ovaries and other forms of cystic disease often resemble ascites, and they occasionally exist along with it. Ovarian dropsy, in its early stages at least, usually affects one side more than the other, and so the distention is not always symmetrical. It leaves, as a rule, one or both of the flanks clear on percussion, and gives a dull note in front, different thus from the disposition of the dulness in ascites. The umbilical ring may be flattened but is seldom protruded, unless there be ascites also. The effect of change of position

FIG. 71.



Position of an *ovarian tumor* of the right side, in various stages of enlargement. The shading indicates the *percussion-dulness in ovarian dropsy of moderate extent*: the umbilical region is dull, from the presence of fluid, and the flanks remain clear. The outer circle shows a further extent to which the dulness may reach in ovarian dropsy. (Bright.)

on the percussion-dulness is scarcely appreciable in ovarian dropsy, or, at least, it is much less than in ascites. Percussion of the lumbar regions, while the patient rests on her arms and knees, sometimes assists the diagnosis by revealing dulness over the diseased ovary behind.

Other cystic diseases are discriminated from ascites in a manner similar to that mentioned in connection with ovarian dropsy—chiefly by their position and by the fluid not being freely movable. Dilated kidney (hydronephrosis, pyonephrosis), cystic disease of the kidney, and parasitic cysts (hydatids) of the liver and of various abdominal organs, including the omentum, are the chief forms of encysted accumulation in the abdomen. Occasionally very soft cancers simulate abdominal dropsy, and colloid material by its escape into the abdominal cavity sometimes gives rise to a semifluid accumulation there: large fatty tumors in the abdomen have also been known to simulate fluid.

Causes of Ascites.—The first point is to ascertain whether the ascites is the only fluid accumulation present in the patient, or if it forms but a part of a more general dropsy. We sometimes require to trace the development of the dropsy in different parts as to their relative dates: thus a case may have begun as a pure abdominal dropsy subsequently becoming complicated with dropsy of the feet. When existing alone, or out of proportion to the dropsy elsewhere, ascites may depend on inflammatory exudations from the peritoneum, or on mechanical obstruction to the portal or mesenteric veins. When associated with general dropsy, ascites may simply form a part of a more general affection; an examination of the heart and of the urine will assist the diagnosis. When the dropsy is almost exclusively abdominal we consider the following causes:

1. *Peritonitis* with considerable effusion is almost always chronic or subacute. The tenderness which we are in the habit of looking for in inflammation of the peritoneum, is often very slight, or, indeed, absent, if there be much effusion: cases of this class are usually due to tubercular, or, it may be, cancerous affections of the peritoneum: in the latter, the exudations may be due in part to the compression of veins by the cancerous nodules, and in part to the inflammation set up: this inflammatory element may account for the partial subsidence of a dropsy in obviously malignant affections. By applying the hand over the abdomen in the umbilical region, and by wriggling it about in various directions and with vary-

ing pressure, we can, at times, perceive a grating or crackling sensation, from the rubbing together of rough surfaces, or from the presence of fluid in the meshes of the inflammatory exudations: a similar sense of friction may be conveyed to the hand or the ear applied to the abdominal wall during a prolonged act of inspiration: care must be taken not to confound this with the noises occurring within the intestines themselves. When such friction can be made out in a case, it points clearly to inflammatory mischief or complication. Occasionally peritoneal friction can be felt or heard over the liver, and is developed in cases of abdominal dropsy, especially in the terminal stages of renal disease.

As chronic peritonitis with effusion is usually tubercular, considerable assistance may often be derived from a consideration of the age, family history, and general aspect of the patient, from the presence of evening pyrexia, and from the concurrence of other symptoms and signs of tubercular disease —glandular masses in the abdomen (tabes mesenterica), ulceration of the bowel, pulmonary phthisis, pleuritic effusion, etc. Cancer is usually associated with but little disturbance of the temperature, but rapidly developed cancer in the peritoneum and elsewhere may run a febrile course.

2. *Tabes mesenterica* is a cause of ascites in children which must never be forgotten; but it is not so common as is often supposed; tubercular peritonitis often resembles this form of disease, and the large belly of rickets is even at times confounded with this very serious disease. Tabes mesenterica is rare under four or five years of age. The dropsy in tabes is usually purely abdominal; any other, if present, can generally be made out to be quite secondary: the distention of the abdominal veins is an important sign of this form of dropsy in the young, but somewhat similar distention is seen in malignant growths in the abdomen, as these likewise obstruct the venous circulation. Occasionally a mass of large mesenteric glands can be felt through the abdominal walls. The general symptoms of wasting disease, and the occurrence of evening elevations of the temperature, the presence of pulmonary phthisis, the existence of abdominal pains, of capricious appetite, of occasional disturbance of the bowels, and the history of any tendency to tubercular disease in the family, must all be carefully considered in doubtful cases. This glandular disease may be associated with tubercular peritonitis.

3. *Portal Obstruction.*—Disease of the liver causes ascites from its affecting the portal vein, either in its main trunk, or

in its ramifications in the hepatic structure. Various diseases of the liver, as well as affections of other organs in its neighborhood, may thus give rise to ascites; indeed, anything which obstructs the portal circulation tends to give rise to abdominal dropsy. The two common affections of the liver thus associated with dropsy are cirrhosis or atrophy of the liver, and cancer. The former, when extensive, leads to the obliteration of so many minute branches of the portal vein, that it can scarcely fail to give rise, in time, to dropsy; but in cancer much depends on the accidental position of the malignant nodule, as to whether it happens to press on or destroy the portal vein or its branches. Along with cancer of the liver, we must consider cancerous growths in the pancreas, glands, and other parts in the neighborhood of the vena portæ, as these can seldom be separated clinically from hepatic affections. Perihepatitis (by compression of the portal vein from the contraction of the lymph effused in its neighborhood) likewise causes ascites; and occasionally enlarged glands in the fissure of the liver complicate amyloid disease as well as cancer, and so give rise in this way to ascites. Hydatid cysts, abscesses, and any tumors or swellings in the liver may likewise, from their particular positions, give rise to ascites. Prolonged congestion of the liver—whether of a mechanical nature, as seen in long-standing cases of heart-disease, or resulting from the pernicious influence of alcoholic stimulants—is apt to lead to induration of its tissue, and obstruction of the portal circulation, and so gives rise to peritoneal dropsy. Thrombosis of the portal vein sometimes produces a rapidly increasing ascites, and this cause should be considered when the dropsy suddenly assumes an alarming form, threatening asphyxia from its bulk: it is usually due to preëxistent disease of the liver, or other organs concerned in the portal system, but it occasionally arises here, as elsewhere, from a very depraved state of the blood.

In investigating these causes of ascites, we try to discover the size of the liver and any peculiarity in its form: the evidence of other results of portal obstruction and the history of any causes likely to give rise to such diseases must also be searched out.

In cirrhosis, the whole organ is usually small, sometimes, indeed, keeping quite within the margin of the ribs; occasionally, however, it is not diminished in size, and perhaps in the early stage it may even be unduly large. The surface of the cirrhotic liver is often uneven, with little "hob-nail" projections, seldom exceeding a pea in size; these can be felt in some cases on moving the hand from side to side over the organ, or dipping the fingers down over its edge; not unfrequently there are certain irregularities in the tendinous walls of the abdomen, which are apt to mislead us in such examinations. The nodules in cirrhosis are smaller than those usually found in cancer. The spleen is generally enlarged in cirrhosis of the liver, but this can seldom be made out if there be much fluid in the abdomen. Jaundice, in an extreme form, is rare in cirrhosis, but the patients have often a dingy or earthy complexion, with dark rings at the orbits; if jaundice be present at all it is slight, and the bile is not quite absent from the stools, unless, indeed, there be coincident catarrh of the ducts, or some other similar complication.

In obstruction of the portal vein the branches going to its formation are more or less involved, and so, in addition to exudations into the peritoneum, there is a tendency to disturbance of the stomach and bowels, especially vomiting of blood, passing of blood by the bowels, the existence of hemorrhoids, the occurrence of tarry motions, and an enlargement of the spleen. The habitual presence of a sediment of very red lithates in the urine, obvious imperfections in the nutrition, and the previous history of spirit drinking, are further points to be inquired for. Drinking of undiluted spirits is the common cause of cirrhosis of the liver, but it occurs at times quite apart from this habit, and has even been seen in young children. Bleeding from the nose and subcutaneous hemorrhages are also occasional symptoms in cirrhosis of the liver.

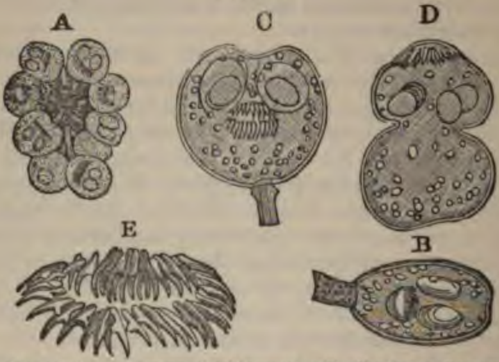
In cancer of the liver, the whole organ is usually enlarged, but sometimes only one part appears affected: the surface often presents very distinct nodules of the size of a marble or even larger, with at times a central cup-like depression: these nodules are usually painful, or, at least, tender on pressure, but cancer of the liver sometimes runs a painless course. This affection of the liver is generally secondary to cancer somewhere else—if judged from the pathological standpoint; but clinically, it is often impossible to get evidence of any other organ having been affected, and even when the liver is involved secondarily, the primary cancer may be in the gall-bladder, the bile-ducts, or other parts intimately related to the liver. Careful search, however, should be made for evidence of cancer in the stomach, rectum, or elsewhere, and the glandular regions should be explored for any swellings. Hereditary tendencies to malignant disease are sometimes traceable in the family history, but they are no doubt often missed, even when really present. Jaundice, like dropsy, is not a constant sign of hepatic cancer, but when deep persistent jaundice, with pale stools, coexists with ascites, it adds great probability to the diagnosis of a cancerous mass compressing both the bile-ducts and the portal vein. The combination of jaundice and ascites, however, is also found in cirrhosis of the liver. (See p. 427.)

An excessively enlarged spleen is sometimes the only obvious cause of abdominal dropsy.

The examination of the abdomen as to the presence of tumors, or even as to the size of the liver and spleen, is often extremely imperfect, owing to the distention of the parts by fluid accumulation; by dipping the fingers suddenly down through the fluid or by varying the position of the patient, we may discover an enlargement of the liver or spleen, which might otherwise escape notice. When, however, paracentesis has been resorted to, an opportunity is afforded, *immediately after the operation*, of exploring the parts, owing to the great flaccidity of the abdomen; the spleen can often be thus felt, and nodulation of the liver then discovered; cancerous masses in the omentum, peritoneum, or mesenteric glands, can often be easily felt at this time, although, perhaps, in no other way.

The examination of the fluid removed by tapping may help the diagnosis, but reference must be made to special treatises for full details regarding these various fluids and their characters. The occurrence of blood in the fluids removed, especially by aspiration, is often noticed toward the end of the operation, very likely from the withdrawal of the support afforded by the fluid to the vessels within: the presence of blood probably favors the coagulation of the fluid removed. Coagulation of the fluid, when very considerable, suggests the presence of inflammatory processes; slight coagula, sometimes blocking the canula, may occur in all forms of ascites, but as they form no part of the characteristics of ovarian fluids, this may aid the diagnosis. Chylous fluids with a milky appearance are occasionally met with: some implication of the thoracic duct may explain this. Occasionally the fluids removed, particularly after tappings which have not done well, may indicate purulent admixture. The fluid in *simple dropsy* is usually clear, with a specific gravity of about 1.012-1.015; it contains, as a rule, but little blood, although highly albuminous; bloody serum has, however, been observed in the dropsy due to portal obstruction. Ascitic fluids vary much in specific gravity (1.012-1.035), and also in the quantity of albumen which they contain. *In cases of cancer* the fluid may be of the same character as that of simple dropsy, even when the disease involves the peritoneum, but in cancerous cases blood is a more frequent constituent. *An hydatid cyst*—unless contaminated with effused blood and the products of inflammation—yields a clear fluid of low specific gravity, about 1.007-1 009, without albumen or urea, and with abundance of chloride of sodium. Moreover, echinococci or hooklets may usually be found on microscopic examination. (See Fig. 72.) *Urine* may be recognized by its odor sometimes, or by its yielding crystals of nitrate of urea on the addition of nitric acid, after concentration or extraction with alcohol. Urea may be found in the dropsical exudations of the abdomen due to renal disease, but when it occurs in a cystic accumulation, the kidney or the bladder must be thought of. Urine from a dilated kidney (hydronephrosis) is usually of a very low specific gravity; it may contain a trace of albumen. The possibility of *complex fluids* from the rupture of cysts, the effusion of blood, and the products of inflammation must be remembered: dark chocolate-colored fluids with shreds, etc.; coming away on tapping are usually due to such causes.

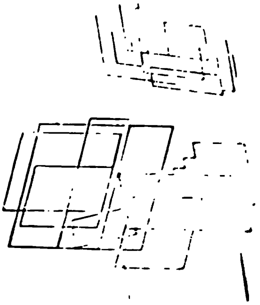
FIG. 72.



Human echinococci. *A*, a group of echinococci, still adhering to the germinal membrane by their pedicles, magnified 40 times; *B*, an echinococcus magnified 107 times; the head is invaginated in the caudal vesicle; a pedicle is attached to it. *C*, the same compressed; the head contracted, the suckers and the hooks are seen in the interior. *D*, echinococcus magnified 107 times; the head is protruded from the caudal vesicle. *E*, crown of hooks magnified 350 times. (Davaine.)

In *ovarian cysts* we have, as a rule, somewhat dark-colored fluids, sometimes slightly, sometimes extremely ropy or even gelatinous. In such cases we occasionally see glittering specks with the naked eye, shown by the microscope to be scales of cholesterine. (See Fig. 73.) These are commonly found in encysted fluids, but their presence has been recorded in chronic inflammatory peritoneal effusions also: they assist but do not settle the differential diagnosis of ovarian from peritoneal dropsy. Ovarian fluids may, however, present a close resemblance to peritoneal exudations; they are often clear and sometimes of low specific gravity. The specific gravity of ovarian fluids varies from 1.003–1.045. In parovarian cysts the fluid is, as a rule, clear, of very low specific gravity, and with little or no albumen: occasionally, however, such cysts may also have dark, ropy fluid. The detection of "paralbumen" in abdominal fluids has been alleged as diagnostic of an ovarian origin, but this substance has now been found in other forms of disease. "Paralbumen" is not precipitated by heat, although the fluid may become turbid. The action of dilute acetic acid assists its recognition; like mucin, paralbumen is precipitated by this reagent, or at least a turbidity is produced, but the turbidity due to mucin is not dissipated by excess of the acid, or by the addition of a strong solution of chloride of sodium, while the turbidity in the case of paralbumen is dissolved by both of these reagents. Paralbumen is precipitated by alcohol; so is a substance named "metalbumen," but this latter again is not precipitated by ferrocyanide of potassium and acetic acid as paralbumen is. Some confusion exists as to the reaction of "paralbumen;" indeed, the various forms of albumen do not seem as yet sufficiently well determined. Another test often applied is to boil the fluid, and after obtaining a coagulum, to add strong acetic acid, which redissolves the precipitate from ovarian fluids, or renders it gelatinous after it is shaken, [illegible]

FIG. 73.



Crystals of cholesterine. (Otto Funke.)

Mixtures of ordinary albumen and of these several forms of albumen frequently [illegible] and tend to [illegible] the results of the tests.

The microscopic examination of ovarian fluids may [illegible] cholesterine crystals as already mentioned and represented, [illegible] pus, blood, epithelial cells and compound granular [illegible] Dr. Drysdale [illegible] as a granular [illegible] ovarian fluids. It [illegible] does not [illegible] become more transparent [illegible] Absolute reliance cannot [illegible] Groups of pear-shaped [illegible] fluids due [illegible]

Murchison [illegible] 3d edition [illegible] of the Liver [illegible]

Society, 2 vols., London, 1858–61.—Wickham Legg, On the Bile, Jaundice, and Bilious Diseases, London, 1880: this work contains a mass of historical information, copious references, and a full account of acute yellow atrophy of the Liver.—MacMunn, The Spectroscope in Medicine, London, 1880.—Habershon, Diseases of the Abdomen, 3d. ed., London, 1878.

Spencer Wells, Diagnosis and Surgical Treatment of Abdominal Tumors, London, 1885.—Lawson Tait, Pathology and Treatment of Diseases of the Ovaries, Birmingham, 1883.—Bright, On Abdominal Tumors and Intumescence, New Sydenham Society, London, 1859.—There are many other books on ovarian tumors; reference may also be made to the treatise on diseases of women mentioned in Chapter XV.—For general dropsy, see Basham, The Significance of Dropsy as a Symptom in Renal, Cardiac and Pulmonary Disease, 3d edition, London, 1866.

Various works referred to in Chapter XIII. on urinary disorders, and in Chapter XVI. on the physical examination of the chest and abdomen, may also be consulted.

CHAPTER XIII.

EXAMINATION OF THE URINE, AND SIGNIFICANCE OF URINARY SYMPTOMS.

THE urine is usually examined to some extent in all hospital cases on admission as a matter of routine. The nature of any further examination is determined by the character of the case. In private practice the examination of the urine is called for on the detection of any suspicious symptoms likely to be associated with urinary disturbances; and the beginner will do well to examine it in all cases where the diagnosis remains doubtful. Patients also frequently complain of changes in the character of their urine; these will be referred to in describing the naked-eye appearance.

The routine examination of the urine embraces its reaction, its specific gravity, its color, and other naked-eye appearances; also a determination of the presence or absence of albumen, and of the character of any sediment, microscopically and otherwise. These points should be *noted* in all hospital cases on admission, even if the results seem purely negative in their indications, as they may be of much value in the subsequent development of the case. The nature of the further investigations depends to some extent on the results of this examination. Thus, if the specific gravity be high, especially in a pale urine, sugar must be tested for and the quantity of urine ascertained. If the specific gravity be low and the color pale, a measurement of the quantity passed in the twenty-four hours will be important. In cases with albuminuria some notion of the quantity of the urine is usually desirable to guide not only the diagnosis, but also the prognosis and treatment; sometimes exact measurements of the quantity of the urine are of the utmost value. Special circumstances in the case determine the further investigations. Thus the propriety of a quantitative estimation of the chlorides in febrile cases, of the urea in a variety of diseases, of the presence of biliary and other pigmentary matters, etc., must be determined by the general clinical features of the case.

The samples to be selected for testing depend to some extent on the points specially aimed at in the inquiry. For the reaction, the sample should be recently passed, and if alkaline the relation of the specimen to meal times must be considered. For the specific gravity the whole quantity passed in the twenty-four hours should be tested, or a sample taken from it. In examining for crystals or tube-casts, the sample should be allowed to settle quietly and completely for several hours. In suspected albuminuria we may have to examine samples passed at different periods of the day, as in slight cases the albumen is often absent in the urine passed before breakfast, and appears in considerable quantity after going about a little, or after breakfast or dinner. The urine passed in the early morning gives the fairest sample of the secretion, apart from the influence of special meals. In private practice it is a good plan to try to procure two separate samples passed, the one in the morning and the other at night. In hospital, the early morning samples may be ordered to be kept in the first instance, and the whole quantity or special samples subsequently ordered, as occasion seems to require. Too much care cannot be taken in securing the purity of the samples, both as regards the cleanness of the vessels into which the urine is originally passed, and of the urine glasses and bottles in which the samples are preserved. Dirty vessels promote speedy putrefaction, and give rise very readily to ammoniacal odor, and to the development of vibriones. The presence of syrups and the like, in imperfectly washed bottles used for the samples, may give rise to serious mistakes. In hospital practice another danger arises from the samples being contaminated with tube-casts and crystals from the urine of neighboring patients, who may have been using the same vessels.

In some cases of purulent and bloody urine, it is desirable to have the sample passed into two glasses, so as to examine the first and second portions separately, as this sometimes brings out certain peculiarities in various forms of urinary disease.

Quantity.—This varies in health according to the bulk of the patient, the quantity of his food and drink, and the amount of his excretions by the skin, bowels, etc. It may be roughly estimated at from 30 to 50 or 60 fluid oz. in the twenty-four hours. In disease the modifying influences referred to have also some play. In particular, a profuse discharge from the bowels or skin naturally lessens the urine. The quantity of the urine should always be considered in its relationship with the specific gravity, as this sometimes enables us to understand and estimate the value of the changes which occur. Thus in a urine diminished by diarrhœa the specific gravity may rise; in a urine increased from great quantities of fluid being imbibed the specific gravity may fall. There is often a difficulty in preserving the whole urine passed by a patient, partly from forgetfulness or indifference on his part, especially if he be well enough to go about, and partly from the great tendency the urine has to be passed at stool and so lost. By getting the patient to pass water before going to stool this loss may often be prevented, and in male patients a wide-mouthed bottle can easily be used simultaneously. Sometimes, however, the loss is inevitable, both from this cause (as in diarrhœa) and from the urine dribbling away, or from its being passed unconsciously and without warning.

Suppression of urine, or even any great diminution in its amount, is always a serious fact in disease; but the report is sometimes given that there is suppression of urine when really it is retained in the bladder. When the quantity of the urine is as low as 10 or 20 oz. in the twenty-four hours, it must be regarded as small; it sometimes, however, falls to a few drachms only. Diminution or suppression of urine is liable to occur in acute nephritis and in the terminal stages of various forms of Bright's disease. In cases with much fever, and in those with copious vomiting, the urine is diminished. From nervous causes it may also be greatly reduced, as in hysterical ischuria; a secretion of copious urine is, however, a much commoner feature after a paroxysm of hysteria.

When above 60 oz. it is decidedly increased, if such figures be maintained for several successive days; but we must remember that the amount oscillates from day to day in health and also in disease. Increased secretion of urine (polyuria) is found in certain stages of lardaceous disease of the kidney, and in granular contraction of the kidney, where the amounts often reach or exceed 100 oz. In diabetes the quantities are seldom much under 100, and often go up to 300 or 400 oz. or more. It is well (owing to the confusion arising from various measures in this country) to have the urine measured in fluid-ounces, or, if the quantities be large, in imperial pints of 20 fluid oz.

When the quantities passed are moderate, they may sometimes be preserved with advantage for our inspection in large glasses graduated in ounces, and in this way the quantity can be read off and the specific gravity of the whole can be readily taken.

Specific Gravity.—This is usually taken by means of the urinometer which is introduced into the sample, in a urine glass, and the level of the fluid on the stem gives the reading, as calculated for a temperature of 60° F., pure water being 1000. The level of the general surface of the urine should be taken and not that of the drop which runs up the stem: it should be seen that the instrument floats freely and does not adhere to the sides or the bottom of the glass. As a rule, we need not be very particular as to the temperature being exactly 60° F., but we must not take the specific gravity when the urine is newly passed and so much hotter than this temperature, as this might lead to an error of three or four degrees of specific gravity. The stem of the hydrometer should be long, so as to give accurate readings more easily, and as these instruments are often wrong in their graduation some test of their accuracy is desirable, by comparing them with a standard or by the use of the balance. When the quantity is too small to allow of the instrument's floating freely, a narrower vessel, or some means of displacing the fluid, may enable us to manage our purpose. The specific gravity bottle is of course available in the case of the sample being very small, or of greater accuracy being desired, and specific gravity "beads" are sometimes useful for small samples. An ingenious method of obtaining the specific gravity from *one* bead, by a process of dilution, has been devised by Dr. Oliver.[1]

In testing a series of urines, the hydrometer should, of course, be dried to prevent contamination of one specimen by another. As already stated, the specific gravity of the sample noted should be that of the twenty-four hours' quantity, or, if not, allowance must be made for a possible deviation: in many cases the specific gravity of samples passed at different hours of the same day varies enormously. The specific gravity must, as already stated, be considered in relation with the quantity passed; the normal is usually quoted from 1.015–1.025. *High specific gravities* (above 1.025) are found in diabetes (from sugar); in urines with a concentration of the normal ingredients from febrile or other diseases, or from a limited consumption of fluid; in the scanty urine of acute renal dropsy; and in rare cases, from an enormous quantity of albumen being held in solution. *Low specific gravities* (below 1.015) occur in nearly all cases (except diabetes mellitus) where the quantity is large; especially in diabetes insipidus; in cases of lardaceous disease of the kidney, with a large secretion of urine; and in general in all chronic cases of Bright's disease. Temporary depression of the specific gravity is met with after large imbibition of fluids, in hysterical affections associated with a profuse flow of urine, and also in the gush of water escaping from a hydronephrosis, and in rare cases, even in the small quantities which succeed in passing the mechanical impediment if both ureters be obstructed: the specific gravity differentiates scanty urine in the last-named cases from that passed in acute nephritis, where the specific gravity is always high in proportion to the degree of suppression.

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[1] The apparatus may be obtained from Wilson & Son, Harrogate.

By doubling the last two figures of the specific gravity, we obtain a rough estimate of the number of grains of *solids* per 1000 (Trapp's formula). Or by multiplying the number of ounces of urine passed in a day by the last two figures of the specific gravity, we obtain an approximation (rather in excess) to the total number of grains of solids thus excreted: in health we may say 50 oz. of sp. gr. 1.020=1000 grains (50×20) for an average man.

The reaction of urine is tested with blue and red litmus paper, or with delicate test-paper which becomes red or blue with acid or alkali respectively. Normally the urine is acid; but even in health it may, occasionally, be neutral or slightly alkaline at certain parts of the day, and especially after food containing many alkaline salts. The acidity may be unusually great (as in lithiasis): the degree can be determined by the alkalimeter. In certain depressed states of the general health, in some cases of abundant acid vomiting, in some forms of spinal paralysis, and in long-standing disease of the bladder with retention or incontinence, the urine is habitually alkaline, and the reaction has thus a certain value in diagnosis. Normal urine often becomes more acid for some hours after being passed (urinary acid fermentation); but all urines which are allowed to stand long enough decompose and become alkaline, from the conversion of the urea into ammonia, so that we must see to have the samples fresh. Alkalinity from ammonia (volatile alkali) may be discriminated from that due to soda or potash (fixed alkali), by exposing or gently heating the test-paper which has been turned blue by the urine, as the volatile alkali is in this way driven off, and the red color returns. The reaction of urine is of value in the recognition of urinary deposits: a bulky deposit which forms soon after the urine is passed may usually be pronounced to consist of uric acid or its salts (urates), if the reaction be acid; if, on the other hand, such a deposit concurs with an alkaline or even a neutral reaction, the probability is that it is phosphatic (the addition of an alkali to normal urine precipitates the phosphates). The persistence of pus in urine of acid reaction points to a renal origin, pus from the bladder, if persistent, usually renders the urine alkaline and ammoniacal. Care must be taken to have the samples fresh in such cases, as urine with much pus, from any cause, rapidly decomposes. Alkalinity of the urine is sometimes a point aimed at in treatment by the administration of potash or other alkaline medicines (rheumatism, lithiasis, gout): the reaction must be determined by *frequent* testing in such cases, as the urine rendered alkaline by remedies readily becomes acid unless the doses are frequent and sufficiently strong. On the other hand, medicines seem to have little chemical power in rendering an alkaline urine acid. Benzoic and carbonic acids, however, seem to have some influence in this respect.

The obvious characteristics of urine are of importance not only as regards the samples we examine ourselves, but also as regards the description of alterations complained of by patients. Both of these will be considered here. Normal urine has a pale yellow tint, is clear when passed, but deposits, on standing, a *faint cloud of mucus*, which forms only a slight sediment. This mucus is sometimes more abundant than natural, as in slight catarrh of the bladder, and this excess may pass gradually into a deposit of muco-pus. When the cloud is absent, this usually implies some excess in the quantity of the urine, which has thus washed away or diluted the mucus.

The color and clearness of urine vary much. Tables of colors have been devised by Vogel to assist the naming of the variations; he makes nine gradations; pale yellow, bright yellow, yellow; reddish-yellow, yellowish-red, red; brownish-red, reddish-brown, brownish-black. If the urine be turbid, it should be ascertained, if possible, if it were so when passed, or if it only became so afterward. Turbidity, when freshly passed, may depend on decomposition going on within the bladder, or on excess of vesical mucus, or on the presence of renal epithelium and shreds, pus, blood, semen, and prostatic secretions, bile, uric acid, urate of soda (hedge-hog crystals), phosphates, chyle, or sarcinæ. When the urine is clear on being passed and afterwards becomes turbid, this is usually due to the precipitation of urates or of phosphates, or to decomposition, or saccharine fermentation. When the sediment has completely fallen, sometimes the supernatant fluid is perfectly clear; sometimes it remains slightly turbid from some remaining admixture of the sedimentary matter.

Patients frequently complain of the urine being *high colored and scanty;* this often arises from simple concentration of the secretion in febrile diseases, apart from any special renal affection, but it also occurs in acute nephritis. Urine *white like milk* is often spoken of in the case of children, and this character is usually due to the presence of white urates or colorless uric acid crystals. In adults, if the urine be *milky when passed*, this is usually due in their case to the presence of earthy phosphates (arising, perhaps, from a transient alkalinity of the urine after dinner), unless persistent this is of little importance; or the turbidity may be due to decomposition and the formation of ammonio-magnesian phosphates: or to the presence of pus, which is always of more or less serious significance; in rare cases it may be due to chyle, to spermatic fluid or sarcinæ. When the patient describes the urine as "*turning thick,*" this is almost always due to a deposit of urates on the cooling of the urine, and is seldom of much consequence. When the urine is spoken of as "*resembling porter,*" the presence of bile in some quantity is usually indicated, but blood may also give such a color. When described as *turbid and smoky* when passed, this may be due to a slight and intimate admixture with blood; a *blood-red color* in a more pronounced form depends on a quantity of florid blood being passed; clots may also come away either of a florid color or of a darker hue, or even of a *chocolate* appearance. *Very red urine*, having something of the bloody tint, is sometimes due to excessively red urates, especially as found in certain hepatic cases. *Very pale* urine is found usually when the quantity is habitually excessive, as in diabetes, and in certain forms of chronic diseases of the kidney; or it may also concur with a temporary increase in the quantity, from free imbibition of fluids, or in connection with hysterical or nervous attacks in both sexes. Anæmia may also be responsible for the paleness of the urine. *Black* urine is sometimes passed by those using carbolic acid or creasote, either externally or internally; more frequently this black color only appears after the urine has been kept for a time; the addition of a minute quantity of strong vitriol (unpurified) frequently brings out a greenish color in such cases, but this test is rather uncertain. A dark red or almost black color is sometimes found in the urine in cases of melanosis. *Indigo-blue* has occasionally been found in urine after it has been standing for a time and has become alkaline. *Bad odor* in the urine when passed depends, as a rule, on decomposition occurring within the bladder, or on the escape of an abscess into it, and is significant of cystitis, etc. Certain vegetables impart a strong odor to the urine, and the smell of many articles used in the food or drink may be recognized in the urine. In oxaluria a certain resemblance to the odor of sweetbrier may sometimes be recognized, and during the administration of turpentine there is sometimes a smell as if from sweet violets, but this cannot be said to be unpleasant. *Gas* coming with the urine suggests some communication of the urinary passages with the bowels. *Shreds* and fibrous masses may be passed in cases of chronic inflammation of the bladder, or they may come from an inflamed and dilated kidney (pyelo-nephritis). *Gritty matter or gravel* may also be complained of as coming with the urine and irritating the urethra: this will usually be found on examination to be due to uric acid, or, more rarely, to other forms of calculous concretions. *Urinary sediments* usually demand chemical tests or microscopic examination for their discrimination. (See pp. 470–496.) Crystals of uric acid can often be seen by the naked eye, or with a simple lens, resembling cayenne pepper grains, falling to the bottom of the glass, or adhering to its sides, or to shreds of mucus. Glittering, colorless prisms of ammonio-magnesian phosphate can also sometimes be thus seen floating as a scum on the surface of the urine, or resting on the mucous sediment, or adhering to the sides of the glass. A very delicate white powdery sediment covering the top of the cloud of mucus, and resembling, as has been said, fine powder dusted over a wig ("powdered wig deposit"), can sometimes be recognized with tolerable certainty as due to oxalate of lime crystals; occasionally, in alkaline urines, minute phosphatic crystals simulate this appearance, but, as a rule, the latter are more glittering than the former; deposits of cystine in acid urines may resemble oxalates very closely. Fawn-colored, pink, or reddish amorphous precipitates, formed as the urine cools, can usually be recognized at once by the naked eye as composed of urates (urate of ammonia, potash, and soda); when the deposit is whitish, there is more difficulty; white urates, or even uric acid, earthy phosphates, and pus, may be scarcely distinguishable from each other by the naked eye. *A glairy whitish or yellowish material*, floating on the surface of the urine, or diffused through it, is often seen when the sample is contaminated with leucorrhœal discharges. Urine with a whitish turbidity *forming a coagulum* on standing is mixed with chyle.

SUGAR IN URINE.

Sugar should be tested for in any complete examination of the urine, and especially in all cases in which diabetes is suspected; when the quantity of urine is excessive, or the specific gravity unusually high (above 1.030); when there is excessive thirst; when great loss of strength or of flesh has occurred without obvious cause; when eruptions of boils or itching at the urinary orifices are troublesome; and when any of the other symptoms of diabetes may present themselves. It should also be remembered that in certain cases of cerebral disease, with or without distinct paralysis, and particularly in some cases of cerebral tumor, sugar appears in the urine. When examining for sugar, albumen should also be tested for, not only because its presence is a serious complication in diabetes, but also because the presence of albumen may interfere with the certainty of the reactions for sugar by the copper test; in such cases the albumen should be separated by heating, with the addition of a little acid, and subsequent filtration. Boiling the albuminous urine with crystals of sulphate of soda is likewise said to yield a fluid suitable for the application of the copper test.

Copper Test—Trommer's Test.—This is based on the power which diabetic sugar has of reducing copper salts from the cupric to the cuprous state under certain conditions. A few drops of a strong solution of sulphate of copper are mixed with a little urine in a test tube, liquor potassæ is then cautiously added, just enough to dissolve the precipitate which it throws down in the first instance; the mixture is boiled, and if sugar is present, a red precipitate of the cuprous oxide falls down. Errors are frequently made in applying this test from not using the proper quantities or proportions of copper and potash with the urine.

Fehling's test solution[1] obviates some of these difficulties. A portion of the test fluid is first boiled in a test tube; we notice if it remains unchanged in color (as it is apt to become altered by keeping); if unaffected, one or two drops of the suspected urine are added; if diabetic sugar be present in any quantity, the color at once changes, and a yellowish or reddish precipitate comes down. If this does not happen, a little more urine should be added (but always so as to be less than the volume of the test-fluid in the tube), and the whole should again be boiled and allowed to cool; if no yellow or red precipitate of the cuprous oxide comes down it may be pronounced free of sugar.

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[1] *Fehling's Solution.*—Sulphate of copper, 90½ grains; neutral tartrate of potash, 364 grains; solution of caustic soda (of sp. gr. 1.12) 4 fluid-ounces. Add water to make up exactly to 6 fluid-ounces. 200 grains by measure are reduced by 1 grain of grape sugar. (Or, 40 grammes of sulphate of copper in crystals; 160 grammes neutral tartrate of potash; 750 grammes caustic soda sp. gr. 1.12; add water up to 1154.5 cubic centimetres. Of this 10 cubic centimetres correspond to 0.05 gramme of grape sugar.) The copper may be dissolved in one-half of the water and the potash with the soda in the other half, both carefully stoppered, and equal volumes mixed when required; in this way the test-fluid may be preserved from decomposing, which it readily does, especially if exposed to air and light.

Caution.—Prolonged boiling must be avoided, as reduction may occur in this way apart from sugar. Boiling the urine before adding the test-fluid is also apt to lead to reduction of the copper even if there be no sugar. Adding too much urine is also to be avoided, as a great excess of non-saccharine urine may reduce the copper. The test-fluid must be in good condition—capable of resisting boiling without being changed; in delicate inquiries, it is desirable to add an equal bulk, or more, of pure water to the boiling test-fluid, to boil again, and to allow the whole to cool slowly so as to have complete security of the perfect condition of the copper solution before proceeding to test.

The quantity of sugar may also be determined by the copper test. Fehling's solution is made of such a strength that 200 grains (by measure) are completely reduced by one grain of diabetic sugar. Of course, great accuracy in weighing and measuring the ingredients is required for quantitative analysis. This quantity of the test-fluid is boiled in a porcelain capsule or a glass flask, and a quantity of pure water, equal to one or two volumes of the test-fluid, is poured in also. The saccharine urine is diluted with pure water, in the proportion of 1 volume of urine to 9 of water, if the sugar happens to be abundant; or in a less proportion (or without dilution) if the sugar is scanty. The diluted urine is introduced into a burette, graduated to grains, and is then gradually added to the boiling copper solution till the blue color is quite discharged. In order to judge of this a minute or two must be allowed for the red precipitate to fall, otherwise it obscures any slight blueness which may remain in the supernatant fluid. When the precipitate falls, by holding up the flask to daylight, or against a white object, or by looking down through the fluid to the white sides of the porcelain dish, if this be used, any remnant of blue color is readily detected. If this can be recognized the mixture is again brought to the boiling point, and a few drops of the diluted urine are again added. Too much time must not be allowed to elapse in waiting for the red precipitate to fall, as after standing for a length of time the cuprous oxide is changed and redissolved, and the blue color is reproduced. The number of grains of urine consumed in the experiment is then read off, and this represents the quantity which contains one grain of sugar; it is then a matter of calculation how many grains of sugar are contained in the ounce of urine (437½ grs. in an ounce avoirdupois). Allowance, of course, is made in the calculation for the degree of dilution employed. If the total quantity of urine passed in the day be known, the total quantity of sugar excreted can then be readily calculated. Similar calculations can be made in grammes and the proportion calculated in percentages.

Pavy's ammoniated solution of copper for quantitative analysis has some advantages over Fehling's solution. Its composition is cupric sulphate, 4.158 grammes; potassic sodic tartrate (Rochelle salt), 20.400 grammes; potash (caustic), 20.400 grammes; strong ammonia (sp. gr. 0.880), 300 c. cm.; water to 1 litre. (Or in English weights, cupric sulphate, 36½ grains; Rochelle salt, 178 grains; caustic potash, 178 grains; strong ammonia (sp. gr. 0.880), 6 fl. oz; water to 1 pint.) The potassic sodic tartrate and the potash are dissolved in a portion of the water and the cupric sulphate with the aid of heat in another portion; the solution of cupric sulphate is poured into the mixture of potassic sodic tartrate and potash, and when cold the ammonia is added; finally, water is added to bring up to the bulk specified. 10 c. cm. of the above solution are reduced by (and so equivalent to) 0.005 gramme of glucose or diabetic sugar.

The advantage of this solution is that the ammonia holds the cuprous oxide in solution, and so the fluid is decolorized when the cupric salt is completely reduced; whereas, in Fehling's solution the red precipitate mingling with the remnant of blue color in the test-fluid renders it more difficult to estimate the complete reduction. 10 c. cm. are measured, placed in a glass flask, and diluted with two volumes of pure water; the diluted urine is then added, just as in the process with Fehling's solution. The only special precaution is to avoid dissipation of the ammonia which would result from prolonged boiling or even from undue slowness in the process of testing. The dissipation is further lessened by passing the point of the buretta through a cork fitting the mouth of the flask, another opening being, of course, provided for the escape of the steam. As the diluted urine is run into the flask containing the boiling solution the change in color can be watched, and when the blue fluid has become as colorless as water we conclude that the reduction is complete, and a calculation can then be made as in the other process. (A simple apparatus for this purpose is made by Cooper, 58 Oxford Street, London; the method is fully described by Dr. Pavy, in the *Lancet* for March 1, 1884, and he there gives a table to facilitate the calculations.) Dr. Pavy has devised pellets for the copper test and definite quantities of his solution in hermetically sealed tubes, but these, although convenient, do not keep perfectly for indefinite periods of time.

Fermentation Test.—Occasionally there are uncertainties in the results of the copper test, when, for example, the reduction of the copper is slight in extent or doubtful in character, and when the urine is rich in uric acid. It is then important to decide as to the presence of sugar by fermentation; sugar is the only substance known which ferments with yeast and liberates carbonic acid gas. A small tube may be nearly filled with the suspected urine, a little yeast is then added, and the whole inverted over mercury in a cup; the apparatus is then put in a warm place and allowed some time to ferment. If sugar be present, in other than very minute quantity, gas accumulates in the tube, and this can be shown to be carbonic acid by testing it, say with lime-water. It is well to conduct a blank experiment with simple water and the yeast at the same time, as a security against the gas being formed in any other way.

Torula Test.—The detection of torulæ (see Fig. 86) occasionally assists in the diagnosis of saccharine urine, or directs attention to its examination by chemical reagents.

The quantitative test by fermentation, as described by Sir William Roberts, of Manchester, consists in determining the specific gravity of the urine before and after complete fermentation. A small lump of German yeast (the size of a walnut) is added to four ounces of urine, the specific gravity of which has first been carefully taken and noted; this is placed in a wide-mouthed bottle (12 ounces), corked, but with an opening cut in the cork so as to allow the carbonic acid to escape; it is then placed in a moderately warm situation, and in the course of twenty-four hours, or when the fermentation is completed, it is allowed to cool, and its specific gravity is again taken at the same temperature as before the fermentation was begun, The loss in the specific gravity indicates the quantity of sugar fermented out. The specific gravity is reduced partly by the loss of the sugar formerly held in solution, and partly, perhaps, by some of the light alcohol thus generated remaining in the mixture. To avoid any fallacy from a difference in the temperature of the fluid at the two separate observations on the specific gravity, it is desirable to have a duplicate sample of the original urine, without yeast, in a 4 ounce bottle, firmly corked, and kept beside the other throughout, so as to compare the specific gravity of the two specimens after the fermentation is over. It has been found, empirically, that one degree of specific gravity lost by fermentation, corresponds with one grain of sugar per fluid-ounce of urine.

Estimation of the quantity of sugar from direct observation of the specific gravity of the urine is, at best, a rough method, as complications arise from the presence, in varying proportions, of the normal solid ingredients of the urine. This source of difficulty is relatively greater when the total quantity of the saccharine urine passed daily is not excessive. A specific gravity which is not excessive cannot, of course, coincide with a high proportion of sugar per ounce; this, indeed, follows from the method of quantitative determination by fermentation, as it has just been stated that the degrees of specific gravity lost in this process indicate an equal number of grains per ounce; if the specific gravity is only 1.030 the number of grains is likely to be under 30, usually considerably under 30, for the ordinary ingredients (urea and salts) of the urine imply of themselves a fair specific gravity (say 1.010 or 1.015), unless indeed the urine is very dilute. A high specific gravity (say 1.045 to 1.050) with a very large quantity of urine (several quarts) may be safely taken as evidence of a high proportion of sugar in cases of diabetes.

Moore's test for sugar with liquor potassæ is a favorite method, on account of its easy application. Equal volumes of urine and liquor potassæ are boiled together, when a dark brown color results in cases of diabetes. This is not a test suitable for small quantities of sugar, and it is subject to fallacies, especially from the presence of lead in the reagent, as this may arise from the glass of the bottles used. This test is often of use in confirming our opinions in the absence of more reliable appliances.

Bismuth Test for Sugar.—A solution of carbonate of soda is prepared in the proportion of one part of the crystals to three parts of water. This solution is mixed with a little of the suspected urine in equal volumes, and a pinch of the basic nitrate (or even the subnitrate) of bismuth is then added, and the whole boiled; if sugar be present the bismuth becomes grayish or blackish from the formation of the suboxide or of metallic bismuth. The test is a delicate one, but is not available for quantitative analysis. When the urine tested is not very watery it is, of course, relatively rich in phosphates, and these are liable to be precipitated by the soda solution giving rise to a white deposit which conceals the blackness of the reduced bismuth. In such urines a preliminary separation of the phosphates, by boiling the urine with the alkaline mixture and filtering or decanting before the addition of the bismuth, may obviate this difficulty.

Picric Acid Test.—In applying this test for determining the presence of sugar we mix an equal volume of urine and of a saturated solution of picric acid, we then add a few drops of liquor potassæ and boil; if sugar is present a deep red-brown color is produced. Inasmuch as many high-colored urines take on a more or less deep color, apart from sugar, when treated in this way, this does not seem a good qualitative test, as the presence of sugar turns on the degree of redness produced.

For quantitative purposes the method seems more reliable, as the exact depth of color can be measured by a process of dilution when definite quantities of the urine and of the reagents are boiled and mixed in tubes of definite diameter and compared with a standard colored solution in a similar tube. Dr. Geo. Johnson has devised an apparatus by which quick results of sufficient accuracy can be obtained. It is convenient to use his graduated tubes which may be obtained from E. Cetti, 36 Brooke Street, Holborn, London, E. C.: full instructions are given with the instrument, or they may be found in a little book by Dr. Geo. Johnson, *On Testing for Albumen and Sugar*, London, Smith, Elder & Co., 1884.

Test-papers for Sugar.—Dr. Oliver has elaborated a system of testing by papers to enable the reagents to be easily carried and to avoid the inconveniences resulting from decomposition in Fehling's solution.

The cupric test-paper is a compound paper; the one with tartrate of cuprammonium, the other with carbonate of soda; these are combined with a layer of rubber. The paper is boiled in sixty minims of soft water, giving a transparent greenish fluid; the papers are then removed and the solution again boiled; a drop of the diabetic urine now added will reduce the copper, whitish streaks and a yellow color appearing; this is hastened by further boiling. If, after such heating and further addition of a drop or two of urine the solution remains transparent, with its green color, we presume there is no distinct amount of sugar.

Indigo-carmine Test-papers.—These have been applied with great ingenuity by Dr. Oliver, both to the qualitative and quantitative determination of sugar; special papers are used for quantitative purposes. The blue color is discharged by the reducing or deoxidizing power of diabetic sugar. Many details and precautions must be observed in using these tests, and as they are fully detailed in the instructions supplied with the test-papers they need not be given here. (Obtained from Wilson & Son, Harrogate.)

The polariscope is available both for the qualitative and quantitative analysis of sugar, provided the fluid be decolorized and freed from any other ingredients (such as albumen) which act on polarized light; but the instruments as yet are rather troublesome and expensive, at least in their accurate forms.

ALBUMINURIA.

The tests for albumen chiefly relied on in clinical medicine are two, and, as a rule, they should both be applied, at least in all doubtful cases. They are (1) boiling, with the subsequent addition of a drop or two of acetic or nitric acid; and (2) the application of strong nitric acid to the cold urine. Some other tests, in particular picric acid, in acid or acidulated urines, may be recommended as good *negative* tests; that is to say, if they give no reaction, when properly applied, the urine may be regarded as free from albumen, but if a precipitate is obtained, this should be subjected to further scrutiny. Various other agents precipitate albumen, and are used for special inquiries—corrosive sublimate, ferrocyanide of potassium with some acid superadded, acidulated brine, mercuric iodide with citric acid, alcohol, ether, chloroform, chromic acid, carbolic acid, tungstate of soda, metaphosphoric acid, etc. Some of these have been introduced into clinical medicine, and may, perhaps, be used occasionally with advantage; but the clinical significance of the precipitates obtained from some of them remains still so doubtful that we fall back with the more confidence on the two methods named above, which have stood the test of long experience. It should be seen to that suitable samples are examined before pronouncing the absence of albuminuria. (See p. 447.)

1. *Test by heat.*—The urine is heated in a test tube to the boiling point, and one or two drops of acetic or of nitric acid are then added. If albumen be present there is a turbidity, or a precipitate, which does not dissolve on adding the acid. If the amount of albumen be small, by heating the upper half of the fluid in the test tube we sometimes can demonstrate the reaction more clearly by comparing the boiled and the unboiled layer. The urine may be turbid to begin with; if this be from urates, they will dissolve on a slight application of heat to the whole quantity in the tube (say 98° F.); the test is not interfered with by this. If the turbidity of the urine cannot thus be got rid of, filtering may be resorted

to. Occasionally a degree of turbidity from decomposition, excess of mucus, or similar causes, may remain, and this interferes with the delicacy of the test for minute quantities of albumen.

Apart from this, which is only a slight imperfection, some fallacies may mislead the student in using the heat test. (*a*) Albumen may be present, but, being held in solution by alkalies, it may not come down on heating; hence the propriety of trying the reaction before boiling, and the necessity of adding acid after boiling, before deciding on the result.[1] (*b*) A precipitate may form on boiling, somewhat resembling albumen, but really consisting of earthy phosphates; such a precipitate is soluble on adding a little acid, a precaution which should never be neglected in applying the heat test. (*c*) If too much strong acid be added to the boiling urine in testing the precipitate which forms, this may dissolve even albumen; excess need not be risked; as the smallest amount suffices to dissolve earthy phosphates. (*d*) Occasionally a minute quantity of nitric acid in the sample of urine (remaining over perhaps in badly washed test tubes) prevents the precipitation of albumen on boiling, from the formation of a soluble acid compound. Sometimes the addition of even a little acetic acid to the urine before boiling may likewise prevent the precipitation of albumen by heat, and so this should be avoided unless guarded in the most scrupulous manner; even a great natural acidity of the urine itself has been known to prevent the precipitation of albumen by heat. The reaction of the urine for the correct application of the test should be just slightly acid. Any acids used to secure this must be applied with caution;[2] in very rare cases alkalies may have to be used to neutralize undue natural acidity.

2. *Nitric acid added to the cold urine* forms a test for albu-

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[1] Occasionally in *acid* urines a faint cloudiness in the boiled portion is developed only after acids have been added—not from albumen, for in acid urines this would show itself on simple boiling, but apparently from the so-called mucin reaction, due to the acid, but intensified by previous boiling.

[2] The addition of acetic acid *before* boiling has often been recommended, but it is attended with danger unless gone about in the most precise manner, as any undue quantity may dissolve the albumen. Sir William Roberts recommends 3 drachms of urine to have 1 drop of acetic acid B P. added to it; on boiling the upper portion of this fluid, a slight opacity reveals the most minute quantity of albumen; if the urine is alkaline it is cautiously neutralized by acetic acid before the final drop is added to the 3 drachms. There is reason to fear that even 1 drop of acetic acid to 3 drachms of certain urines may prevent the precipitation of albumen; and, on the other hand, a minute cloudiness obtained in this way seems at times to be due to other causes than albumen.

Another way of applying the heat test is to acidulate the urine with acetic acid and add one-sixth of its volume of a saturated solution of sulphate of magnesia before boiling.

The method recommended in the text is the one on which the writer places reliance.

men of great value. The delicacy of this test in pale urines of low specific gravity is quite marvellous. The strong nitric acid may be added to a small quantity of urine in a test tube, ten or twelve drops of the acid being allowed to trickle down the side of the tube; the test tube should be held obliquely and raised gently, so as to avoid, if possible, much commingling of the fluids. The acid falls to the bottom, and can usually be recognized from its different color, or (on moving the tube very gently) from its obviously different specific gravity. Another way is to introduce some nitric acid first into a tube, the lighter urine being then poured down very slowly and cautiously, say by means of a pipette, so as to float, without mixing much with the acid. With either method albumen, if present in the urine, forms a cloud just above the level of the acid; or if the quantity be minute, a ring of haziness appears at the junction of the two fluids. A third way of applying this test is to introduce a little nitric acid by a pipette (the outside of the pipette being wiped free from acid) right down to the bottom of the urine in the test tube. All these plans ("contact method") aim at getting the action of the acid localized to a part of the urine without being diffused through it. (A ring of red color merely, without turbidity, at the junction of the fluids does not indicate albumen. This is sometimes very marked, and when highly developed on boiling the acid and urine together, constitutes the "urohæmatine" reaction supposed by Dr. Harley to be due to the loss of blood, as it were, in a disguised form. A ring of green color with nitric acid is found from bile pigment.)

Certain fallacies and difficulties beset the nitric acid test also: (*a*) If the quantity of albumen be minute, some time may have to elapse before the haziness is developed. The tube should be left at rest for a few minutes before pronouncing that there is no haze of albumen. (*b*) Occasionally, on adding nitric acid to the cold urine, a more or less dense precipitate occurs, not from albumen, but from urates. This happens even when the acid is applied as directed; it is more liable to cause confusion if the bad plan be followed of dropping the acid into the urine, but this should be avoided. The urates usually appear first near the surface of the urine, and not at the junction of the urine with the acid, although it often extends that length. A very gentle heat suffices to dissolve this precipitate of urates: this may be done by passing the tube two or three times through the flame of a spirit lamp or by immersing the tube in warm water; in applying heat for this purpose we must avoid anything like a boiling temperature, as albumen itself is dissolved if boiled with excess of nitric acid in the tube. A further confirmation of such a precipitate being due to urates may often be obtained by getting a similar reaction on adding a drop or two of acetic acid to another sample, as this acid does not precipitate albumen in cold urine. (Occasionally, however, an albuminous principle resembling caseine is thus precipitated by acetic acid.) The microscope may sometimes also assist us. The precipitate of amorphous urates may be recognized as such by the microscope; sometimes crystals of uric acid are also quickly formed. (c) Occasionally the addition of nitric acid is followed by the evolution of a multitude of air bells; these are usually plain enough and can be seen rising in the urine. Sometimes the bells are so numerous and so minute, and remain so long in the vicinity of the layer of nitric acid, as to resemble the haze of coagulated albumen. Close scrutiny, and the lapse of a little time, which allows them to rise and dissipate themselves, prevent any error from this cause. (d) When the urine is turbid, the delicacy of the nitric acid test is lost. Filtering may assist us in such a case, but besides being troublesome it is apt to be imperfect in its effect. When the turbidity is due to urates (the commonest cause), by heating very gently, or adding a little warm water, a clear fluid can be obtained on which to operate, and by keeping the tube slightly warm (in warm water or in the warm hand), this clearness may be maintained long enough for the satisfactory application of the test. (e) A precipitate formed at the bottom of the acid consisting of nitrate of urea seldom presents any difficulty as regards distinguishing it from albumen; it is crystalline, readily soluble at a very gentle heat, and usually it takes a long time to form, although it sometimes appears in a few minutes when the urine is loaded with urea and the temperature is low. (f) An opalescence from the use of cubebs and copaiba is occasionally encountered. (g) A haze from mucin, quite above the level of the acid, and sometimes in the form of a ring, seldom leads to error.

A dilution of the nitric acid with five volumes of a saturated solution of sulphate of magnesia lessens the corrosive properties of the acid, which are so objectionable, without impairing seriously the delicacy of the test.

Other tests for albumen have been recommended, especially of late. The most important of these will be noticed shortly.

Picric Acid.—A saturated solution in water (about six grains to the ounce, is prepared. If this be dropped into an albuminous urine an opacity forms around each drop; this is readily dissipated on shaking, but after the accumulation of a certain number of drops the opacity becomes persistent. If the urine is not distinctly acid the albumen may fail to show an opacity till enough of the reagent has been added to cause an acidity from the picric acid itself; but as this is a weak acid, some other should be used—say citric acid or a little dilute acetic acid. A more delicate plan, the "contact method," is to float some of the picric acid solution on the surface of the urine, after acidulating with citric acid; this is readily done by a pipette, as the test solution is much lighter than most urines. Albumen at once appears as an opacity at the junction of the fluids. If the urine is too light to permit of this method, its specific gravity can be increased by adding to it some drops of a saturated solution of citric acid or of a solution of common salt. The fallacies which beset this test depend partly on the possible precipitation of urates on adding the necessary acid, and partly on other substances besides albumen being precipitated by picric acid. In particular, alkaloids (of which the commonest and most important is quinine) are precipitated by picric acid. Peptones are also precipitated by picric acid, and they are occasionally found in urine. The precipitate from urates, alkaloids, and peptones are all dissolved on heating, so that when a precipitate is obtained by picric acid it is essential to proceed further and try the effect of heat; if the precipitate remains after heating, then we may presume that albumen is present; on the other hand, if no precipitate occurs on adding picric acid to the cold acidulated urine, we may presume that albumen is absent with as much certainty as can be obtained from any one test.

The only remaining fallacy consists in the development of a distinct but usually slight haze, particularly when the picric acid is used by the "contact method;" this occurs in a great many urines which we have every reason to believe to be free from albumen. The production of this haze has been supposed to be due to mucin, but this is not certain. It is not due merely to the citric acid used in the test, although this and other acids used in testing urine appear at times to develop this reaction. Some authorities try the reaction with strong citric acid alone, and if the picric acid alone gives more than this does, they infer there must be something more than mucin to give rise to it. This confusion, of course, only occurs in connection with the suspicion of very minute quantities of albumen.

The fallacies in connection with the picric acid test may be summarized: (*a*) Alkalinity of the urine or inadequate quantity of the picric acid may prevent the precipitation of the albumen; citric acid should be added and the picric acid used in excess. (*b*) Urates and occasionally uric acid may be precipitated from the urine by the citric acid or other acidulating agent or even by picric acid alone in rare cases; this precipitate dissolves on heating. (*c*) Alkaloids in the urine are precipitated by picric acid; quinine, if taken by the patient, even in moderate doses, may give this precipitate; it is dissolved on heating. (*d*) Peptones in the urine are precipitated by picric acid; these are dissolved by heat. (*e*) Slight opacities may occur from the so-called mucin reaction simulating minute quantities of albumen.

The ferrocyanide of potassium test has long been known; a few drops of a solution of this salt, with a little acid, precipitate albumen. As in other tests involving the addition of acid, we may have urates precipitated as well as albumen. Of late *pellets* have been used with advantage in applying this test, as they are very portable. An acid pellet and a ferrocyanide pellet (kept in separate bottles) are added to the cold urine in a test tube or a wineglass. If no precipitate occurs, we may presume that there is no albumen present. If a precipitate forms, the application of heat or the addition of a little warm water may serve to indicate the presence of urates which would be dissolved by this. (Those recommended by Dr. Pavy may be obtained from Cooper, 66 Oxford Street, London.)

Ferrocyanide test-papers have been devised by Dr. Oliver. A ferrocyanide paper and a citric acid paper are put into a narrow tube with 60 minims of pure water, and after a little gentle agitation to dissolve the reagents, the papers may be removed. The urine is then dropped into the test-fluid thus extemporized, and if albumen be present in such quantity as to be readily recognized (in one minute) by the nitric acid test, it will appear as an opacity before six drops have been added. The addition may be carried up to thirty drops of the urine. This method of dropping in the urine is alleged to overcome the fallacy from the precipitation of urates. The delicacy and portability of these test-papers are great recommendations.

The mercuric iodide test requires the addition of some acid, say nitric acid. (The "potassio-mercuric iodide" solution consists of mercuric chloride 2.70 grammes; potassium iodide 6.64 grammes; distilled water 100 c.cm.) When this is dropped into the acidulated urine, a whitish precipitate appears if albumen be present. Precipitates also occur from urates, from alkaloids, and from peptones, as in the picric acid test, but these are dissolved on heating as described above. Traces of opacity on using this test occur in a multitude of urines presumably quite normal, so that some caution and the use of confirmatory tests are imperatively demanded if a reaction is obtained. If no reaction occurs, the negative evidence—as to the absence of albumen—is very strong.

Mercuric test-papers are recommended by Dr. Oliver to be used in the same way as the ferrocyanide papers. A mercuric iodide paper and a citric acid paper are put into a narrow tube with 60 minims of pure water and the reagents dissolved out by gentle shaking, after which the papers may be removed. The urine is then added drop by drop, and four drops suffice to produce an opacity if albumen be present in quantity sufficient to be readily recognizable (in one minute) by the nitric acid test. If no reaction occurs on adding twenty drops of the urine, we may say there is no trace of albumen; but if any precipitate forms, this must be tested by boiling it before we can say albumen is present, as alkaloids and peptones are precipitated by this reagent.[1]

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[1] Dr. Oliver's test-papers, both for the qualitative and quantitative determination of albumen and sugar with the tube pipettes, and scales required, may be obtained from Wilson & Son, Harrogate.

The acidulated brine test consists of a saturated solution of common salt with one per cent. of strong hydrochloric acid. This is applied by the "contact method" in the same way as nitric acid. It is a very delicate test, but as it precipitates other things as well as albumen, it has been abandoned by Sir William Roberts, who introduced it.

The quantity of albumen may be roughly estimated by judging of the extent of the precipitate formed on boiling, especially after it has been allowed to subside in the tube for a definite time (say twenty-four hours: its amount may be thus estimated at a half, a fourth, an eighth, etc. Sometimes the quantity is indicated by saying a "trace" of albumen, or "slight," or "moderate," or "large" amounts, as the case may be; or that the urine is solidified on heating. Such indications are of clinical importance, but the estimate thus made has little chemical value. The estimation by precipitation and weighing is so troublesome as to be practically unavailable in clinical medicine.

The polariscope may also be used for determining the amount of albumen in the absence of any other matter affecting the ray of light. This instrument is too costly in its good forms to be often available.

Dr. Oliver's test-papers (ferrocyanide of potassium, and mercuric iodide) have been ingeniously adapted for giving approximate quantitative results by means of estimating the degree of transparency or of opacity resulting from the reagents.

Picric acid has also been employed, especially by Esbach, for determining the quantity of albumen. (Graduated tubes for this purpose may be obtained from Cetti, 36 Brooke Street, Holborn, London.)

The quantitative determination of albumen by nitric acid, as proposed by Sir William Roberts, is based on the fact that the reaction with this test takes longer to show itself in proportion as the albuminous solution is dilute. Indeed, in very slight degrees of albuminuria several minutes are required to bring out the haze with nitric acid. The test consists in diluting an albuminous urine to such an extent that the haze becomes perceptible in a definite time, when a definite quantity of urine is treated with a definite quantity of nitric acid, in a tube of a definite width. The quantity used is 5 cubic centimetres of the fluid in a test tube ⅝th of an inch (15 mm.) in its internal diameter; the nitric acid is applied by a pipette drawn to a point, holding 10 or 12 minims when immersed to the depth of 2 inches; the acid is discharged against the side of the tube while it is held at an angle so as to prevent mixing of the fluids, the dilution aimed at is such as to give rise to a haze appearing not sooner than 35 seconds and not later than 45 seconds. The tube must be held up to the daylight and watched carefully with some black object, such as a coat sleeve, in the vicinity. If the reaction appears before 30 seconds, more dilution is required; if not till after 45 seconds, less dilution must be employed. A drachm measure for the urine and a pint measure for the water serve the purpose of diluting, and these fluids must of course be well mixed. If higher dilutions are required, the drachm of urine may first be mixed with one or two volumes of water before the further dilution in the pint measure is begun. One or two rough experiments before beginning careful dilution may guide us as to the number of volumes with which we should begin. Most albuminous urines can stand at least one volume of water being added, so as to give this reaction in the time named (35–45 seconds); some may require as much as 200 or even 300 volumes of water to bring them to the necessary state of dilution. The state of dilution required for the reaction within the time named is termed the "zero;" each volume of water required to be added is termed a "degree" of this scale.. The value of each degree was calculated by the balance to be equivalent to 0.0034 per cent. of albumen (or 0.0148 gr. per fluid-ounce). If, then, a urine showed 250 degrees of albumen we multiply by this fraction: thus $250 \times 0.0034 = 0.85$ per cent. of albumen, if we wish to calculate the total loss of albumen per day, we multiply the number of ounces passed by the 437½ grains contained in an avoirdupois ounce, multiply this again by 0.85 (as determined above) and divide by 100: this gives the answer in grains of dry albumen.

In applying this method we must, of course, obtain a proper sample of the whole urine passed in the twenty-four hours.

In addition to the estimation of the total albumen passed in a day this method supplies by its varying scale of degrees some definite figures instead of vague expressions as to the abundance of albumen in urine, as "20 degrees," "60 degrees," "100 degrees," "200 degrees," etc. (See Medico-Chirurgical Transactions, vol. lix. London, 1876.)

PEPTONES AND MODIFIED FORMS OF ALBUMEN IN URINE.

The subject of the various albuminous matters found in urine is still very confused, and the detection of peptones there has added to the confusion. Certain reagents seem to precipitate all the substances of this class—as picric acid and mercuric iodide: on the other hand, heat and nitric acid in the cold precipitate serum albumen and globulin, detecting albumen in combination with acids and alkalies, but leaving the others in solution. The ferrocyanide of potassium test does not precipitate peptones in *urine*.

Globulin held in solution in the urine by the salts is precipitated when such a urine is dropped into a quantity of pure water, giving rise to a milky or opalescent appearance. *Paralbumen and metalbumen* have been already alluded to in connection with the fluids in ovarian cysts. (See p. 444.) *Hemialbumose* is partially coagulated by heating but is redissolved on boiling, reappearing, however, as the fluid cools: this seems to be the substance described by Dr. Bence Jones as found in the urine in a case of osteomalacia: the precipitate with nitric acid in the cold was dissolved on heating, and also reappeared on cooling. *Peptones* are thrown down by picric acid and mercuric iodide, but the precipitate is dissolved on heating. By separating the albumen by heat and filtration and then applying the reagents which precipitate peptones, and seeing if the application of heat clears up the opacity resulting therefrom, we may discover peptones if abundant. An accurate separation and testing of peptones is too intricate a matter for ordinary clinical work. A test by means of Fehling's solution is relied on by some, but seems rather uncertain. On floating a solution of peptones on this fluid a rosy-red color is produced at the junction. When urine is thus floated on Fehling's solution we may find a zone of opacity at the junction from phosphates (due to the alkaline solution), and above this the rosy tint is looked for if peptones be present. It must be remembered, however, that albuminous urines give a colored reaction with Fehling's solution which is said to have more of the violet tint, but the distinction is not always plain, and if peptones and albumen happen to be both present the result is confusing. Peptones have been found in urine along with pus, and in some cases of suppuration going on elsewhere: they seem also to have been met with in the urine of women after delivery, in cases of pneumonia and pleurisy, of rheumatism with effusion, and in some of the infectious fevers: they have also been supposed to result from imperfect digestion and from derangement of the liver, and it has been thought that peptonuria may sometimes precede a regular albuminuria. As yet, definite information on these points cannot be supplied.

The clinical significance of albuminuria is very variable; it is sometimes of the utmost importance in diagnosis, and at other times of scarcely any account.

When due exclusively to the presence of blood, pus, etc. (as revealed by the microscope), the clinical significance of the albumen turns of course on the significance of these ingredients, and must be considered under these headings. Sometimes, however, the amount of albumen seems out of proportion to the amount of blood or pus contained in the sample: in such cases the want of a convenient quantitative test for albumen and blood is much felt, but an experienced eye can usually judge pretty safely from comparing the variations in the amount of albumen occurring with different quantities of pus or blood. Sometimes a notable variation in the amount of blood and pus deposited in different samples from the same case, with but little change in the quantity of albumen precipitated on heating, leaves no doubt as to the presence of albumen apart from, and in addition to, the blood and pus which may be found.

Many acute febrile diseases often give rise to albuminuria for short periods, without the diagnosis or prognosis being seriously affected thereby. In typhus and enteric fevers, smallpox, scarlatina, diphtheria, and malignant sore throat, erysipelas, pneumonia, pleurisy, pericarditis, acute rheumatism, meningitis, acute tuberculosis, puerperal fever, and acute suppurations of various kinds, albuminuria is often detected: it has then its chief significance as one of the features of the general disturbance; there is, however, in certain cases even then the beginning of a serious local affection.

After the primary fever has subsided. notably in scarlatina, and occasionally in smallpox, erysipelas, and enteric fever, albuminuria is observed as a recognized sequela. In the case of scarlatina, indeed, it may be said to be of almost habitual occurrence; and when albuminuria appears in a member of a family affected with this fever, or when conjoined in the individual himself with desquamation of the cuticle, arthritic pains, hydrothorax and other well-known sequelæ of scarlatina, it often enables us to recognize an attack of this disease in a patient who would not otherwise have been known to be so affected.

In pregnancy and the puerperal state albuminuria is not infrequent, and although not necessarily of grave import, it is always significant of possible dangers (convulsions during labor, chronic renal disease, etc.).

Chronic chest complaints are often complicated with albuminuria, and this has great importance as regards prognosis (chronic bronchitis, emphysema, phthisis, chronic pneumonia, pleurisy or empyema, heart disease, aneurism, mediastinal tumors, etc.). Sometimes in such cases, and especially in heart disease, the albuminuria is only one of the indications of a general venous congestion which may pass off quickly or may linger for a long time; sometimes it is indicative of a nephritis favored by renal congestion; sometimes, on the other hand, the renal disease, of which albuminuria is the sign, may be justly regarded as the primary fact, and the affection of the heart or lungs as a complication.

In all dropsies the presence or absence of albumen is important. Occasionally genuine renal dropsy exists without albuminuria, but this is so rare as to make such a diagnosis demand very special proof. Albuminuria, on the other hand, may be regarded as presumptive evidence of a renal origin for the dropsy, in whole or in part; but the mischief in the kidney may be dependent, as just explained, on general venous obstruction due to cardiac, hepatic, or ovarian disease, or to dropsy of the peritoneum, or to any cause giving rise to direct pressure on the renal veins.

In acute or chronic renal disease of all kinds, whether with or without dropsy, the detection of albuminuria is of the greatest value: concurrent evidence from the presence of blood or of renal derivatives in the urine (tube-casts, epithelium, etc.), from alterations in the specific gravity and the quantity of the secretion, from local pain, and from the general features of the case, may come in here to help the diagnosis.

In *nervous diseases* the existence of albuminuria is of importance, but the nature of the connection in such cases is variable.

Sometimes the nervous affection is a tolerably direct manifestation of the renal disease, as in uræmic convulsions, coma, blindness, or delirium: sometimes the nervous affection is due to organic changes associated with the renal disease, as in hemiplegia due to cerebral hemorrhage associated with hypertrophy of the heart, rigid arteries, and disease of the kidney. At other times albuminuria may be regarded as an effect of the nervous disease, as in the temporary albuminuria due to an epileptic or other convulsive fit, and the albuminuria produced by certain inflammations, tumors, and other lesions of the brain.

In many chronic and constitutional affections we must watch for albuminuria: phthisis, syphilis, scrofulous disease of the joints and bones, and profuse suppurations generally, are often associated with albuminuria due to lardaceous degeneration of the kidneys. Cases of chronic indigestion and depressed states of the health, with habitually alkaline urine, or with persistent deposits of oxalate of lime, gouty attacks, and the like, must be particularly watched in respect of this symptom, both because of the frequent complication of such cases with albuminuria, and because symptoms of the class just indicated are often the earliest manifestations of renal disease. Other chronic diseases, as diabetes, jaundice, cancer, exophthalmic goitre, and lead poisoning, are often complicated with albuminuria.

Remedial agents, especially *blisters*, may give rise to a transient albuminuria, sometimes with, sometimes without, hæmaturia and strangury.

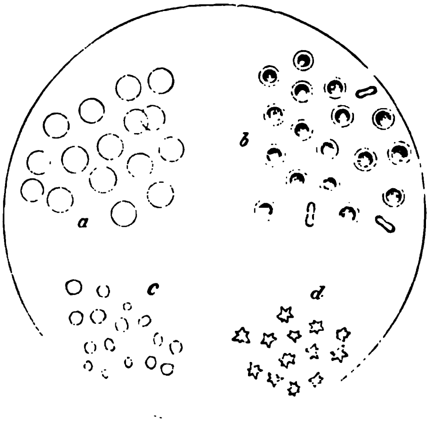
In the midst of so many possible sources of albumen in the urine, we must fall back on the history and the general symptoms and features of the complaint to guide our diagnosis; and in particular, we must have regard to the persistence and to the quantity of the albumen, and to other evidence of derangements in the urine, as respects its quantity, its specific gravity, its color, and the presence of tube casts, renal or other epithelium, pus, blood, crystals, parasites, etc.

Blood in the Urine

is always to be regarded as important. Sometimes its appearance is so far accidental: thus the possibility of the admixture of menstrual blood with the urine, or of slight bleeding from the use of the catheter, must be borne in mind; the possible existence of more serious injuries to the genito-urinary organs must not be ignored, although these do not belong to purely medical practice.

Blood in the urine can often be recognized by the eye from its giving a dingy or smoky tint to the urine, especially when the blood comes from the kidney and is intimately mixed with it. Sometimes it has a darker hue, resembling chocolate. All gradations of red or blood-color, with or without clots, may be found, especially when the blood comes from the pelvis of the kidney, the ureter, or bladder. When the blood is present in any distinct quantity the existence of an albuminous reaction may be calculated on with certainty, and the presence of this may serve to confirm our suspicion of blood, while the absence of albumen should make us suspect some fallacy if the blood-tint seems pronounced. Occasionally, however, the appearance of a perfectly distinct blood-color may coexist with the merest trace of albumen: indeed, it may happen that a reduction in the amount of albumen coincides with the appearance of blood in the urine in very distinct quantity. The microscope assists the diagnosis of hæmaturia by determining the presence or absence of blood corpuscles, and these may be seen in cases in which no albumen can be detected by the tests. The red blood-corpuscles are recog-

FIG. 74.



Blood corpuscles in urine. *a*, Slightly distended by imbibition; *b*, Showing their biconcave contour; *c*, Shrivelled; *d*, Serrated. (Roberts.)

nized by their size being smaller than that of pus, or mucus, or white blood-corpuscles, and by their having the double outline due to the biconcave character of the disks (Fig. 74, *b*). It frequently happens, however, that the blood disks in urine are swollen up, by the absorption of fluid, into a globular form, and this peculiarity is consequently lost; occasionally their edges are serrated from similar physical causes (Fig. 74, *a*, *d*). A fallacy is not unfrequently presented by globular vegetable spores simulating the microscopic appearance of red blood-corpuscles.

FIG. 74*.

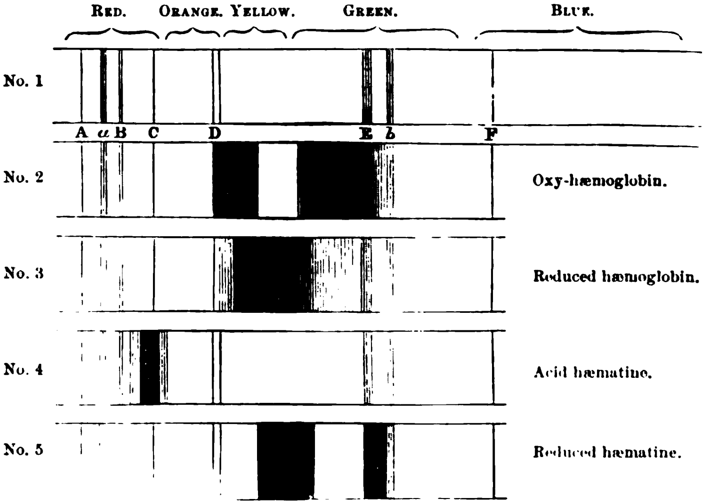


Diagram showing the position of the Fraunhofer lines in the solar spectrum (No. 1); and the absorption bands of hæmoglobin and hæmatine (Nos. 2 to 5).

A chemical test for blood (or hæmoglobin), by means of guaiac, is often of value. Two or three drops of the urine are placed in a test tube, a couple of drops of tincture of guaiac are added, and a few drops of "ozonic ether" are then shaken up with the whole. The ether dissolves the precipitated resin, or goes to the surface and carries up with it a distinct bluish color if blood be present. The peroxide of hydrogen in the "ozonic ether" is very liable to undergo decomposition, and so we must be sure of the activity of our reagents before deciding that there is no blood. In testing a urine it is also necessary, when the quantity of blood is minute, to allow it to settle, and to apply our test to a few drops lifted from the sediment by a pipette, as the corpuscles containing the hæmoglobin fall to the bottom. This reaction can also be obtained at times from minute traces of hæmoglobin in the urine, in scarlatinal dropsies, even before the albumen appears, as judged by the ordinary tests (so-called "pre-albuminuric stage"); or for some time after it disappears ("post-albuminuric stage"). It would appear, however, that this depends on the great delicacy of the guaiac test, when properly applied, detecting blood in minute quantities which elude the ordinary tests for albumen, unless special precautions are taken.[1] This test is sometimes applied by means of white bibulous paper dipped in the urine, the guaiac and ozonic ether being subsequently applied to the paper when it has dried. If this method be followed, the paper itself must first be tested with pure water, as some papers give a misleading reaction; high-colored urine, from bile, may also mislead.

Another test for hæmoglobin is supplied by the spectroscope. If a solution of oxy-hæmoglobin, presenting a layer of suitable thickness, be interposed between the light and the slit of the instrument, two dark absorption bands are found at the yellow and green portion of the spectrum, between the D and E lines, as shown at No. 2 in the diagram. The first is narrower and more sharply defined at the edges than the second. This is due to oxy-hæmoglobin, such as is found in blood taken from the finger. If reducing agents be applied—*e. g.*, a little ammonium sulphide—the two bands are converted into one; the edges of this are not sharply defined, and it is nearly intermediate, as to position, between the other two. (See No. 3 in the diagram.) If this reduced hæmoglobin be now shaken up in the tube with a quantity of air, the hæmoglobin is again oxidized and the two bands reappear, slowly coalescing into one again as the air bells rise to the surface and escape. This beautiful reaction as described by Professor Stokes, of Cambridge, is conclusive proof of hæmoglobin. Occasionally in bloody urine a third dark band is found in the red part of the spectrum, in the position indicated in the diagram as that of acid hæmatine (No. 4). In such cases this band is regarded as due to "met-hæmoglobin;" its exact nature is obscure, but probably it results from changes or decomposition in the other form. In bloody urine this band in the red never occurs alone; it is always associated with the other two, so that the appearances are as if No. 2 and No. 4 in the diagram were conjoined. When the urine becomes alkaline from decomposition the band in the red may disappear readily, and this is apt to lead to contradictory statements on the part of different observers. (No. 4, "Acid hæmatine," and No. 5, "Reduced hæmatine," in the diagram are only obtained on the application of suitable reagents to blood; they do not occur apart from this.)

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[1] See Dr. R. Stevenson Thomson's paper on this subject, Med.-Chir. Trans., vol. lxix., Lond., 1886.

These tests by guaiac and the spectroscope are of special importance in cases of *hæmoglobinuria*, which often appears in paroxysmal forms (paroxysmal hæmoglobinuria), ushered in by shiverings and associated with fever. In such cases the urine appears to be bloody, but the most careful search may fail to reveal any blood corpuscles, the hæmoglobin having been dissolved out and the corpuscles disintegrated. In such cases the urine is loaded with albumen and the spectroscope reveals the presence of hæmoglobin, in the form of oxy-hæmoglobin, often associated with "methæmoglobin," giving a band in the red. In these cases (formerly called paroxysmal hæmatinuria) we may have chocolate-colored masses in the sediment, occasionally tube-casts are seen, and oxalates are frequently present. The attacks may pass off in a few hours, leaving the urine perfectly clear and free from blood or albumen. They seem to be determined at times by the influence of cold. Other forms of hæmoglobinuria occur in connection with fevers and poisoning.

Clinical Significance of Hæmaturia.—The appearance of blood in the urine (apart from the accidental contaminations from the vagina, etc., already referred to) points either to some general disease attended with bleeding, as in the case of purpura and scurvy, of hæmophilia, hemorrhagic smallpox, and malarial fever, or some forms of disease affecting the bloodvessels generally; or it may be due to the operation of some poisonous agency acting specially on the kidneys—such as cantharides, turpentine, creasote, and alcohol; or to some local affection of the urinary organs and passages themselves—such as inflammation of the bladder or kidneys, cancer of these organs, parasitic disease of the kidney, renal embolism, and calculus in the kidney or bladder; occasionally it is due to the extension or bursting of abscesses, cysts, etc., into some part of the urinary tract from adjacent structures, and especially from pelvic abscesses.

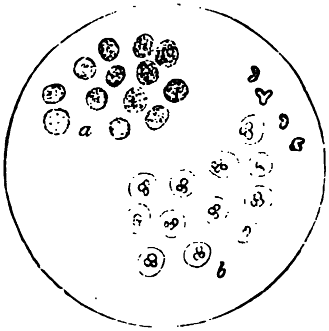
The further discrimination of such cases turns on the aspect of the blood. If intimately mixed with the whole of the urine, imparting a smoky tint to it, the blood is usually of renal origin; minute clots may come from this source, but any considerable clots indicate a bleeding lower down. Sometimes, however, these may come from the pelvis of the kidney. Florid blood and distinct clots point to the bladder, prostate, or urethra. If the blood is passed specially with the last portion of the urine, this usually indicates a vesical origin. If the hæmaturia is associated with excess of mucus or muco-pus, we suspect the bladder; the urine in such cases tends to become alkaline. If the amount of pus varies much from time to time, without ropy mucus and with habitually acid reaction, we often find the explanation in a kidney dilated with pus intermittingly emptying itself. The reaction of the urine, and the discovery of gravel, microscopic calculi, or crystals, may guide us, although these may be irritating either the kidney or the bladder. Parasites detected in the urine may explain the hemorrhage. The kind of epithelium found along with the blood is often of consequence, if we can recognize it as renal or vesical, or as coming from the pelvis of the kidney or the ureter; the so-called "cancer cells" are always to be accepted with dubiety. The detection of tube-casts in a bloody urine indicates that there is a renal element in the case, but it is quite possible that even in such cases the bladder may be responsible for most of the mischief, for the renal affection may be secondary, as in disease working its way back from the urethra and bladder. Again, if we can satisfy ourselves that there is more albumen in the urine than can be accounted for by the blood (or pus) present, this also usually points to a renal affection. The quantity and specific gravity of the urine likewise assist us in determining the presence of acute or chronic disease of the secreting parts of the kidney. Of course, the general symptoms of the case must be strictly inquired into, especially as to pain and its site; its area of distribution, whether over the pubes, in the lumbar and sacral regions, in the thighs, the region of the ureters, or in the penis and testicles; the relationship of the pain to the act of micturition, to the times of rest or exertion, or to any supposed cause of its development, must also be considered. Phthisis may give the clew to the bleeding associated with tubercular pyelitis, and the cachectic appearance of the patient may suggest the idea of malignant disease as the cause of the hemorrhage. A surgical examination of the urethra and prostate, and of the bladder for calculi or growths, may be required to settle the questions here raised, at least in cases of persistent or frequently recurring hæmaturia, associated with painful micturition. The occurrence of shiverings, the circumstances under which the hæmaturia appeared—whether after scarlatina, or in the course of chronic or acute renal diseases, or associated with hemorrhages elsewhere, after a fit of drinking, or in connection with the use of special drugs, or after injuries to the parts, or associated with gonorrhœa and stricture, or in connection with renal colic or tumor, and tenderness in the loins—all these must be inquired into; their significance must be sought for in the description of urinary diseases in special treatises, or in the text-books of surgery as well as of medicine.

Pus in the Urine

occurs sometimes as a microscopic deposit only; at other times it appears in sufficient quantity to present a very distinct and even a bulky sediment. In such cases it may often be recognized by the naked eye, but it is apt to be confounded with phosphatic deposits (and in point of fact it often exists along with them); it may also be confused with white urates. Liquor potassæ, as a reagent, may assist in the discrimination; for urates are dissolved by this agent, phosphates are but little affected, or are rendered more dense by it, while pus becomes ropy or gelatinous on the addition of an equal bulk of liquor potassæ to the purulent deposit: the impossibility of pouring out such a mixture drop by drop is good evidence of this ropiness. Sometimes the pus assumes this ropy character soon after the urine is passed; this is due to the development of ammonia, which acts on pus in much the same way as liquor potassæ does; sometimes the ropiness exists when the urine is passed, from the ammoniacal decomposition going on within the bladder itself. The microscope reveals the presence of pus corpuscles; these when seen may be further tested by the addition of dilute acetic acid, which clears up the granular contents and brings out the tripartite nucleus. (See Fig. 75.) Other white cells are often found in urinary sediments which can scarcely be distinguished from pus; the white corpuscles of the blood, mucus corpuscles, inflammatory corpuscles (leucocytes), and even altered renal epithelium, all resemble pus so closely as to be at times indistinguishable.

Mucus corpuscles may be suspected when the mucous appearance of the sediment is very marked; renal epithelial cells are usually larger than pus corpuscles; the action of acetic acid and of liquor potassæ sometimes assists in various doubtful cases. The reaction of purulent urine, when of renal origin, is usually distinctly acid (if tested immediately on being passed), even in long-standing suppuration; it is usually alkaline and ammoniacal in *long-standing* suppuration from the bladder. When of renal origin, the deposit of pus in the urine glass is often very distinctly demarcated from the supernatant fluid; in vesical suppuration, whether from calculous irritation or not, it is usually more diffused from being mingled with mucus; in both cases it may be associated with blood in various degrees and ways. In renal suppuration, the blood when present usually lies as a distinct layer on the top of the pus; in vesical cases, the blood is often more mixed up with the mucus and pus. Sounding of the bladder is imperatively called for in all doubtful cases with bladder symptoms. The coexistence of mucus, of fibrous shreds, of crystals of various kinds, and of epithelium from the kidney, ureter, bladder, or urethra, is sometimes of great value in judging of the origin of the pus. If much scaly epithelium from the vagina be present, leucorrhœal contamination should at once be suspected, and the use of the catheter may be required to overcome the difficulty of this admixture. Sometimes, in the male, instructive hints may be gathered from the relative abundance of pus in the first half of the urine as compared

FIG. 75.



Pus-corpuscles. *a*, Without reagents. *b*, After the addition of acetic acid. (Roberts.)

with the second, during a single act of micturition; any pus in the urethra is naturally washed away with the first half of the urine, while if the seat of suppuration be in the bladder, it is rather more abundant in the second half, and may be more contaminated with blood; if from the kidney it is usually equally diffused. In suppuration from a dilated kidney the quantity of pus often varies in a remarkable way at different acts of micturition, and some information may be gained by procuring a series of samples in separate glasses. Albumen can be made out by appropriate tests in all cases of excessively purulent urine—from the presence of albumen in the pus itself; but when we can make out a greater amount of albumen than the pus can well account for, there is a strong case for the renal origin of the complaint; we may find, for example, the same quantity of albumen present in various samples, although the pus may vary greatly or may even present an insignificant amount in certain specimens. Very marked albumen with but a slight layer of purulent sediment would imply that the pus cannot have furnished it. A deep layer of pus with mere traces of albumen in the urine leads us to infer that the urine itself is not albuminous. It is, however, often very difficult, or even quite impossible, to get clear evidence on these points, and when blood as well as pus is present, the determination of an independent albuminuria, in addition to these, becomes impossible. As already explained in the case of hæmaturia, the detection of tube-casts is of great value in determining the presence of renal mischief of some kind; but these casts are found in cases of renal irritation from calculus and gravel as well as in Bright's disease and the other destructive lesions of the kidney. A tumor in the loins, when present, often indicates for us the source of the pus in the urine (pyonephrosis); and the kind of crystals found in the sediment may guide us to a diagnosis of the nature of the concretion in case of calculous pyelitis, and of stone in the bladder.

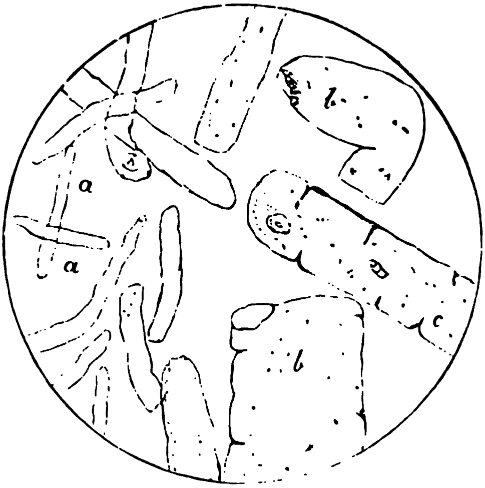
The clinical significance of pus in the urine (pyuria) resembles somewhat that of hæmaturia, and it is equally varied. It may follow acute renal inflammation, and it often appears in cases characterized by copious albuminuria and in cases of Bright's disease following fevers and parturition. It occurs also in renal embolism. As already indicated, the pus may proceed from abscesses in the substance of the kidney, or from suppuration of its pelvis, due to calculus or to secondary mischief working its way back from the bladder or urethra.

Perinephritic abscesses may have communications with the kidney. Pelvic and other abscesses opening into the urinary tract; cystitis, whether of calculous or paralytic origin; cancer of the bladder; inflammation and suppuration of the prostate; gonorrhœa and gleet, whether recent or of old standing, may all give rise to purulent urine. Accidental contamination from lochial or leucorrhœal discharges must also be remembered as of frequent occurrence.

RENAL TUBE CASTS

should always be searched for in cases of albuminuria. They are present in the great majority of cases in which the albumen has a renal origin, but they are occasionally so scanty as to be difficult of detection. The specimen of urine examined for this purpose should have had time to settle thoroughly—for several hours at least; a conical bottom to receive the sediment is useful when the deposit is scanty; the supernatant fluid should be cautiously poured off in such a way as not to disturb the deposit, or, if we have any further occasion for it, some of the sediment may be removed from the bottom by the pipette, and a drop placed on a slide with a cover glass may be examined microscopically with a quarter-inch lens. Occasionally the addition of a little acid to precipitate uric acid crystals, or some other plan of carrying the scanty tube casts mechanically down to the bottom, may facilitate the search. When the reaction of the urine is alkaline, perhaps from the administration of alkaline diuretics, the formation of casts seems to be hindered in the tubes; if alkaline from decomposition, the delicate structure of the tube casts is readily dissolved and destroyed. When the casts are moderately abundant, the only further precautions required are careful illumination and focussing. Many casts are so transparent as to be almost invisible in a strong light, and a narrow diaphragm and some shading, by moving the mirror, may be required to allow of their being caught by the eye. When scanty, a good plan is to put several drops of the sediment in a shallow cell with a cover glass, and examine with a low power (half-inch objective); or to place a drop or two of the sediment on a slide, spread it out (without a cover glass), and pass the whole rapidly in review. If a doubtful structure is seen, requiring a higher power, it can be placed quite in the centre of the field, and the stronger lens brought down upon it; or, as the object glass is thus apt to dip in the fluid, an attempt may be made to place a cover glass over the doubtful structure, and after finding it as before with the low power, we may come down upon it with a stronger lens to define its character. In this way several drops of the sediment may be examined in rapid succession, and tube casts detected which would otherwise have escaped notice. By filling the pipette with the sediment, and allowing it to settle, either by plugging the upper opening or by leaving it to stand in the urine, we sometimes obtain a better specimen for microscopic examination when the sediment is scanty and the tube casts few in number. In other cases again, where the field is crowded with cells or granules, dilution with a little water facilitates the search for casts. If pipettes are used, care must be taken to have them well cleaned; owing to the uncertainty attending this cleansing of narrow tubes, it is often better to pour off the urine and examine a drop of the deposit placed directly on the slide. Shreds of mucus, strings of the amorphous granules of urates, and vegetable growths sometimes assume forms which simulate tube casts.

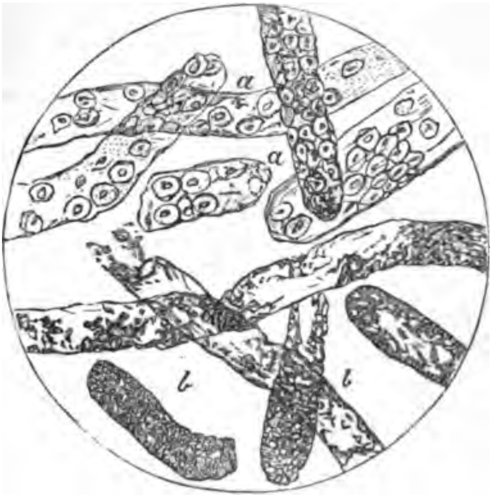
FIG. 76.



Hyaline, or waxy casts. *a*, From a case of chronic Bright's disease of eight months' duration. *b*, From a case of chronic Bright's disease (large white kidney). *c*, From a case of chronic Bright's disease (contracted kidney, with fatty degeneration). (Roberts.)

Tube casts are of very various sizes, both as regards length and breadth. When of large diameter this should be noted, as it is a point of some importance, as indicating a certain dilatation of the renal tubules, or, as some suppose, a loss of the epithelium. They may be (1) perfectly "hyaline"—*i. e.*, clear, transparent, and empty (see Fig. 76). (2) They may be packed full of rows of renal epithelial cells—"epithelial casts" (see Fig. 77, *a*). (3) The cells thus contained may be quite fatty, with obvious oily globules within them, or such globules may lie within the cast—"oily or fatty casts" (see Fig. 78, *a*). (4) The fatty element may be in such a minute state of division as to present only a dark granular appearance —"granular casts" (see Fig. 77, *b*). Various stages or gradations of these four varieties are met with, sometimes even in different parts of the same cast. In addition to these, (5) the casts may contain blood corpuscles, and sometimes only the coloring matter of the blood—"blood casts" (see Fig. 78, *b*); and in the same way (6) "pus casts" are sometimes seen. In estimating the significance of these different kinds of casts too much importance should not be attached to a single specimen;

FIG. 77.

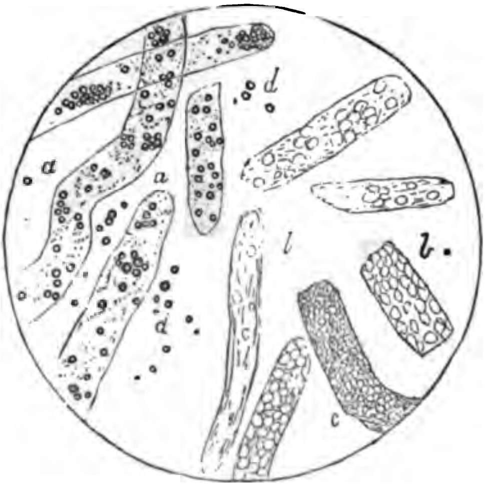


a, Epithelial casts. *b*, Opaque granular casts, from a case of acute Bright's disease. (Roberts.)

the character of the majority of the casts should rather be kept in view.

The clinical significance of tube casts is sometimes considerable, not only in the differentiation of the various forms of renal disease, but as indicating the actual existence of a renal affection in cases involved in doubt. Thus, in bloody or purulent urine (as explained under these headings), where the origin of the blood or pus is obscure, the existence of tube casts clearly points to a renal element in the case. In rare cases this may be due to a complication perhaps not connected directly with the presence of the blood or the pus itself. Renal tube casts do not, however, imply the existence of Bright's disease, as they may arise from the irritation of a calculus; they are then sometimes found with blood and crystals, but not necessarily with either. Tube casts are found in jaundiced urine, quite apart from any serious renal affections, and apart even from albuminuria. With regard to the different kinds of casts, we may say, in a rough way, that epithelial casts and blood casts are found in the earliest stages of an acute parenchymatous nephritis, but very soon thereafter we obtain hyaline casts as the predominating type, and when

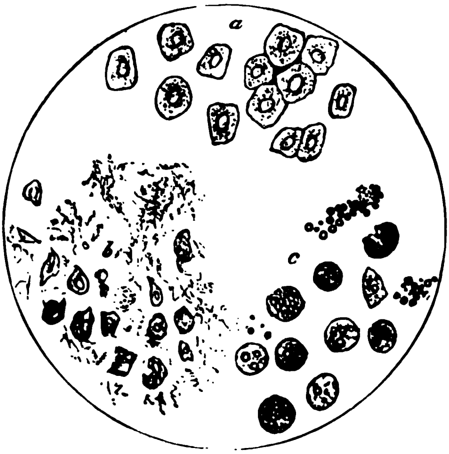
FIG. 78.



a, Fatty casts. *b* and *c*, Blood casts. *a*, Free fatty molecules. (Roberts.)

the inflammatory process has gone on to produce fatty changes in epithelium, these changes are reflected in the tube casts. Granular casts are found in advanced cases of chronic disease of the kidneys, both of the parenchymatous and interstitial type. Hyaline casts occur both in recent and old cases of these forms of nephritis, and are the usual casts found in lardaceous disease of the kidney. Tube casts, as a rule, are abundant in cases of acute parenchymatous nephritis, less abundant in the more chronic forms, and usually scanty in the lardaceous form of renal disease. The exact forms of albuminuria, of renal origin, in which tube casts are really absent, cannot be strictly defined; but when inflammatory changes are absent, mere congestion probably gives rise to but few casts (transient passive congestion, exophthalmic goitre, etc.).

FIG. 79.



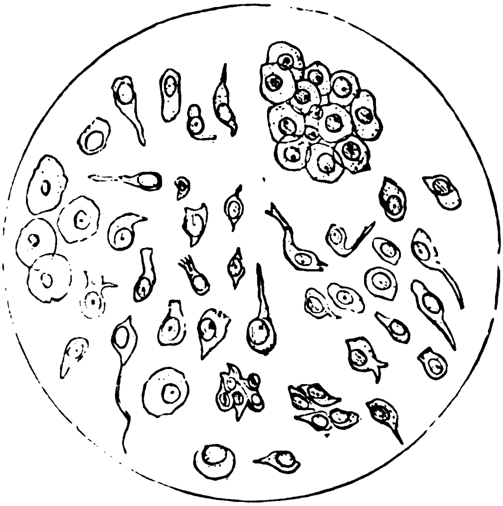
Renal epithelium. *a*, Natural appearance. *b*, Atrophied and disintegrated renal cells. *c*, Renal cells in a state of fatty degeneration. (Roberts.)

There is reason to believe that a tube cast may occasionally be detected in urine which is practically normal.

EPITHELIUM

of various kinds is often found in urinary sediments on microscopic examination, and it is of great importance to determine its character, and, if possible, its origin. *Renal epithelium* lying loose is recognized as being somewhat globular, and it can sometimes be compared with epithelium contained within tube casts in the same microscopic field. (See Fig. 77, *a.*) Occasionally it resembles pus corpuscles, and can scarcely be discriminated from them. Its presence forms an important element in the diagnosis of desquamative nephritis both acute and chronic. It undergoes various changes, the cells appearing atrophied, or granular, or distinctly fatty. Sometimes large *granular corpuscles* are found along with fatty epithelium; these corpuscles, indeed, probably result from altered epithelial cells. Changes of this kind in the epithelium shed from the kidneys are very suggestive of the processes going on in these organs. (See Fig. 79.)

FIG. 80.

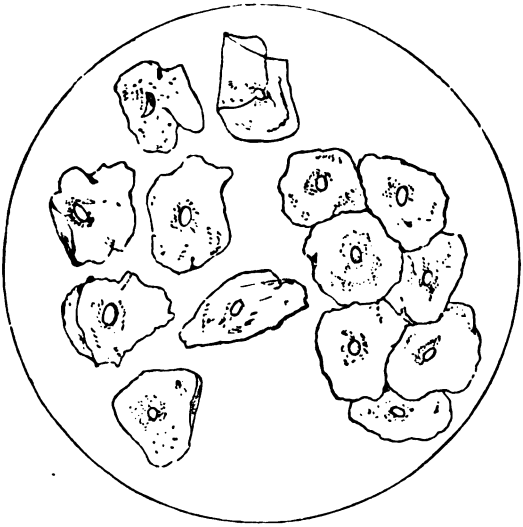


Epithelial cells from the bladder, ureter, and pelvis of the kidney. (Roberts.)

Cells from the bladder often appear as groups of tessellated epithelial cells of circular form; sometimes they are pyramidal. (See Fig. 80.)

Tailed epithelium is found in the ureter and pelvis of the kidney, and sometimes the recognition of such is of value in the diagnosis of calculous pyelitis. (See Fig. 80.) *Large scaly epithelium* is often present as a contamination from the vagina. (See Fig. 81.)

FIG. 81.

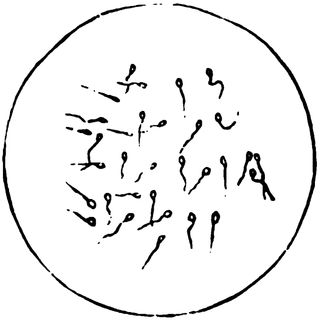


Vaginal epithelium in the urine. (Roberts.)

SPERMATOZOA, BACTERIA, FUNGI, SARCINÆ, HAIRS, FIBRES, ETC.

Spermatozoa are occasionally seen in varying numbers in the urine. They appear in large numbers in the urine after seminal emissions, whether physiological or morbid, and a few

FIG. 82.

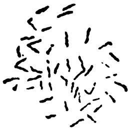


Spermatozoa. (Roberts.)

are often introduced into the urinary passages during straining at stool, etc. When present habitually, they may afford evidence of spermatorrhœa. (See Fig. 82.)

Bacteria, Vibriones, Micrococci, etc.—When urine undergoes putrefactive changes, vibriones (Fig. 83) and other organisms

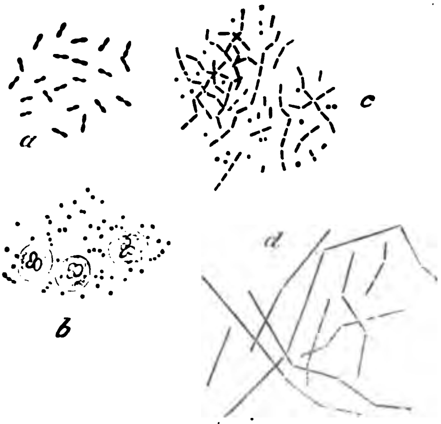
FIG. 83.



Vibriones in urine. (Roberts.)

are found in it, of which the most important, so far as the decomposition of the urea is concerned, seems to be the micrococcus ureæ. (See Fig. 84, *b*.)

FIG. 84.



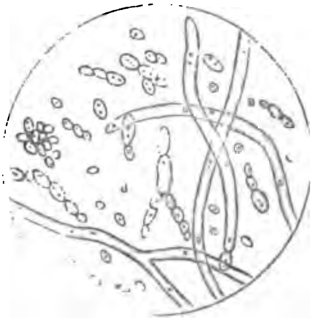
Various kinds of bacteroid organisms found in freshly voided urine: *a*, Bacterium termo; *b*, Micrococcus ureæ; *c* and *d*, Other bacterial forms. (Roberts.)

But the urine may present bacteria when voided without ordinary decomposition having actually begun in a distinct form, but with an undue proclivity to this. In such cases the urine may be slightly turbid when passed, and this turbidity does not settle down on standing. In cases of men with stricture, where instruments have been passed, and in women with leucorrhœal discharges, such urine presents bacteria. (Fig. 84, *a*.)

Another group of cases presents bacteria in perfectly fresh urine with an acid reaction which may, indeed, be maintained for days. The urine in such cases may be at first opalescent from the organisms, but these settle down as a sediment. Various forms have been found, as shown in Fig. 84, *c* and *d*. Chains or threads of micrococci have also been described by Sir William Roberts as found in freshly voided urine. In studying these cases of "bacteruria," the most scrupulous care must be taken to avoid any possible chance of contamination from imperfectly washed glasses, pipettes, etc.

Fungi, Mould, Torula.—In acid urines we may see mould growing, and on microscopic examination we may find various forms of fungi with branching growths and spherical spores. These sometimes mislead the student, being mistaken, the former for tube-casts and the latter for blood corpuscles. The early or rapid development of torulæ is common in saccharine urine, giving rise to turbidity without putrefaction. Hence, when torulæ are abundant, we may be led to search for sugar, but growths of this kind are found apart from this cause. (Compare Figs. 85 and 86.)

FIG. 85



Mould fungus. Sporules and thallus. (Roberts.)

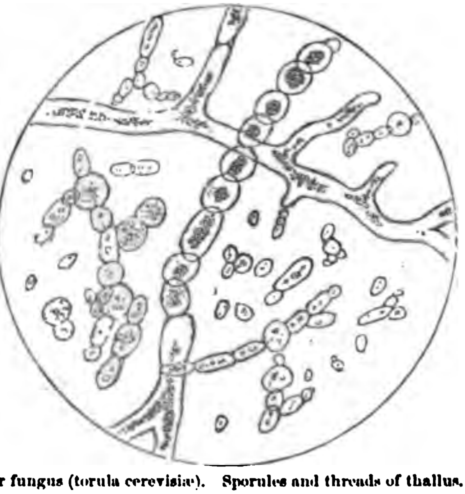
Sarcinæ are only rarely found in urine. They are smaller and paler than those common in the stomach. (See Fig. 60.) They give the urine a turbid appearance when passed, and they settle as a sediment, leaving the urine clear. They are usually associated with more or less distinct symptoms of urinary irritation.

Foreign Matters.—Cotton, flax, fibres, straw, hairs, and feathers are often present in minute fragments from floating dust from the bedding, etc. Air-bells and oil globules (perhaps from an oiled catheter or an oily bottle used for the sample) often puzzle the beginner. (See Fig. 87.)

CRYSTALLINE AND AMORPHOUS DEPOSITS.

Uric acid can frequently be recognized as a red sand in the urinary deposits, lying at the very bottom and in the corners of the glass, or sometimes adhering to the sides, or entangled in the mucus. Although usually highly colored, the uric acid crystals thrown down from pale urines may be almost colorless. Uric acid itself is without color; it only attracts the pigment of the urine. The forms presented by uric acid crystals are very variable, but they may mostly be reduced to modifications of the rhomb. The plates of Dr. Beale give excellent representations of the variations and forms of aggregation usually met with. The following names applied by Sir William Roberts to the crystals may assist in their recog-

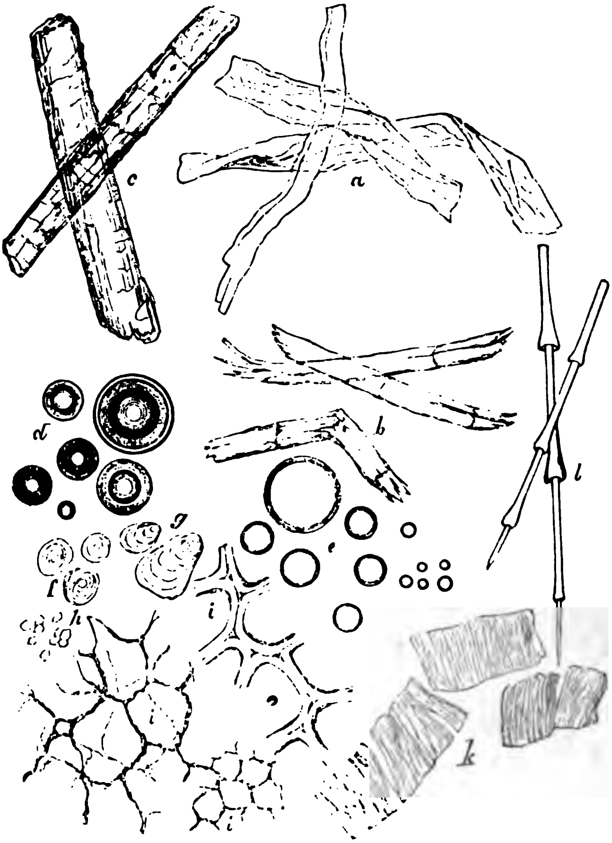
FIG. 86.



Yeast or sugar fungus (torula cerevisiæ). Sporules and threads of thallus. (Roberts.)

nition: quadrangular and oval tablets, cubes, six-sided tablets, lozenges and barrel-shaped figures, stars and spikes, and fan-shaped crystals. (Compare Fig. 88.) The presence of a high

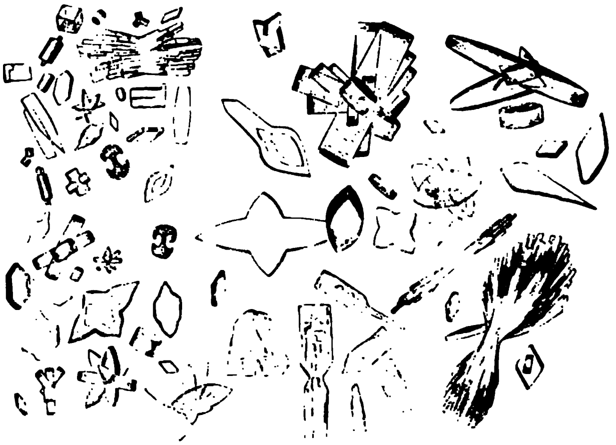
FIG. 87.



Extraneous matters found in urine: *a*, Cotton fibres; *b*, Flax fibres; *c*, Hairs; *d*, Air bubbles; *e*, Oil globules; *f*, Wheat starch; *g*, Potato starch; *h*, Rice-starch granules; *i*, Vegetable tissue; *k*, Muscular tissue; *l*, Feathers.

color often leads us to suspect the nature of these crystals when they might otherwise be puzzling, and the detection of transition forms from well-known shapes often serves to confirm our conjectures. Uric acid is very insoluble in water, and it does not disappear on heating the sediment—a distinction from the deposit of urates. Uric acid is not dissolved by acetic acid; this serves to discriminate colorless uric acid from certain crystalline forms of phosphate of lime. Uric acid is soluble after a time in caustic alkalies, and alkalies administered internally may exercise a solvent power. Uric acid may be passed in the crystalline form from the bladder, and the crystals may then be seen in the fresh urine as red particles, or as causing a general turbidity; they are, however, more often only formed and deposited by the urine after standing for a time; this being due partly to the cooling of the urine and partly to its increasing acidity after it is passed, from a natural acid fermentation. The crystals often increase in size after a time. The addition of a drop or two of strong acid to normal urine precipitates uric acid in crystals. Sometimes the precipitate thrown down by the addition of acid to urine consists of a dense mass of amorphous urates which may resolve itself by and by into uric acid crystals. A sediment of uric acid crystals, on being kept till it becomes alkaline, may be converted into hedge-hog crystals of urate of soda.

FIG. 88.



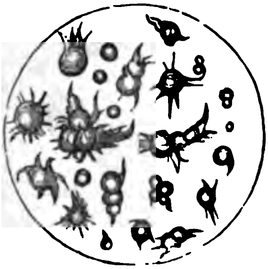
Various forms of uric acid crystals. (Selected from Otto Funke's Physiological Atlas.)

The "murexide test" brings out a beautiful red color on treating uric acid with nitric acid and ammonia.

Urates or lithates are salts of uric acid combined with ammonia, potash, or soda, the exact composition being often very difficult of determination: these bases would seem to be frequently mixed together. Such sediments in the urine are extremely common. They are found in urines which are clear when passed, but become turbid on cooling or after standing for some hours. They are occasionally found in the urine as passed, especially in the case of children who pass milky-looking urine; in such cases this sediment, of *urate of soda,* may be crystalline, presenting the form of globules, either simple or furnished with hedge-hog projections. (See Fig. 89.)

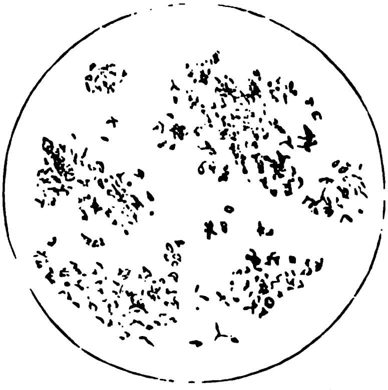
The common form, however, consists of granules of *amorphous urates* (see Fig. 90); these often form aggregations so as to assume the shape of ropes or strings, presenting a superficial resemblance to granular tube casts. The microscope cannot always discriminate amorphous urates from an amorphous deposit of earthy phosphates, but the reaction usually settles the point: urates are deposited on cooling from acid urines; phosphates are found with an alkaline or at least a neutral reaction. The use of liquor potassæ likewise assists, as also the action of heat: both of these dissolve a sediment of urates, but leave phosphates unaffected or may even render such a

FIG. 89.



Hedge-hog crystals of urate of soda, spontaneously deposited from the urine of a child. (Roberts.)

FIG. 90.



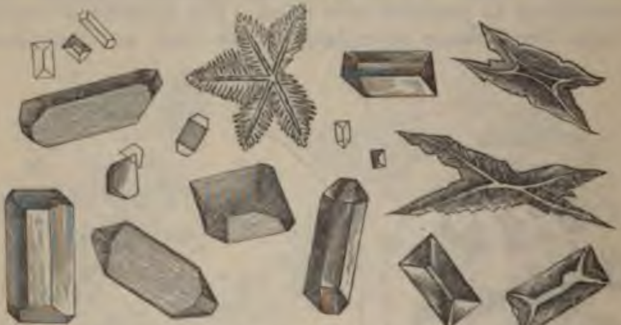
Amorphous urate deposit. (Roberts.)

sediment more dense. The sediments of urates are usually fawn-colored, or pinkish, or even as red as blood. The chemical causes of the precipitation may be considered as connected with the cooling of the urine, with its concentration (from febrile disorders or from scanty supply of fluid), and also with the increasing acidity of the urine after it is passed. Adding a little acid sometimes precipitates urates from a urine in which they may be deposited spontaneously in the course of a day or two. The internal administration of alkalies or diluents often accounts for the disappearance of these sediments under observation.

The murexide test reveals the presence of uric acid in these deposits.

PHOSPHATES appear in two distinct forms, amorphous and crystalline; the crystalline phosphates are of two classes, the crystallized phosphate of lime and the ammonio-magnesian (or "triple") phosphate. The phosphatic deposits often form a white sediment somewhat resembling pus.

FIG. 91.

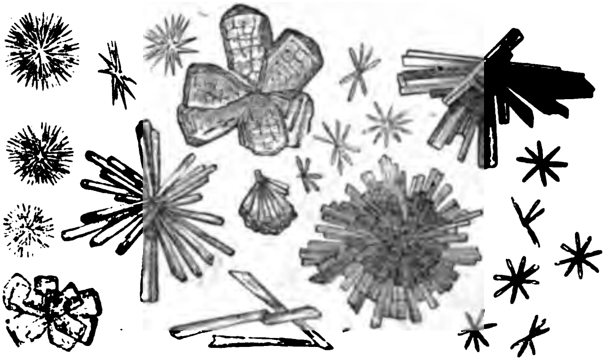


Ammonio-magnesian (or "triple") phosphates. (Selected to show various forms.)

The ammonio-magnesian (or triple) phosphate is the commonest variety, and it may appear in almost any urine which is kept till it decomposes, as the urea thus supplies the ammonia for these crystals. The crystals are usually prismatic. They often form on the surface, appearing as a glittering scum, or the glittering prisms may be seen on the sides of the glass, or entangled in the mucous or purulent sediment. The reaction of such urine is usually alkaline, but it may be neutral or faintly acid. Such crystals are sometimes to be seen in the urine as it is passed, especially associated with pus, and with an ammoniacal odor, from the decomposition going on within the bladder. The forms of the crystals, although essentially prismatic, undergo various alterations, and sometimes they assume a feathery appearance. (See Fig. 91)

Crystallized phosphate of lime appears usually as stars or rods, or as fan-shaped crystals, destitute of color; other forms are also occasionally met with. The action of acetic acid is useful in distinguishing them from uric acid crystals, when the latter are colorless, as the phosphates are dissolved by this acid and uric acid is not. (See Fig. 92.)

FIG. 92.



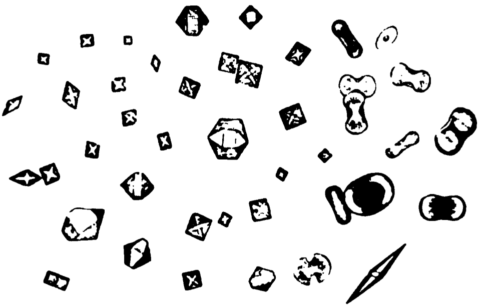
Crystallized phosphate of lime. (Selected to show various forms.)

Amorphous sediments of earthy phosphates are occasionally met with in freshly passed urine, apart from disease, giving the urine a slightly milky appearance; this arises from an accidental alkalinity of the secretion, due perhaps to the kind of food or to some medicine taken immediately before. Boiling the urine (as in testing for albumen) often precipitates the earthy phosphates in alkaline or feebly acid urines, so that the action of alkalies and heat on them is exactly the reverse of what we find with urates. The sediment when unmixed with other deposits is at once dissolved on the addition of acetic acid.

Oxalate of lime deposits can sometimes be recognized by the naked eye as causing a very fine powdery sediment dusted, as it were, over a delicate cloud of mucus ("powdered wig" deposit). These sediments occur in acid urines and disappear if the urine be rendered alkaline by medicines. The crystals are octahedral in shape, but appear at times in somewhat different forms (single or double pyramids). Occasionally they are found in the form of a dumb-bell, or ellipsoidal, or reniform crystals. (For the various forms see Fig. 93.)

Oxalate of lime crystals are sometimes passed as such from the bladder (indeed the dumb-bell crystals are alleged to be sometimes formed within the tubules of the kidney), but oxalate of lime is usually crystallized out of the urine after it has passed, and the dimensions of the crystals can often be seen to be increased after a time; dumb-bells may change into octahedral crystals by keeping. Oxalate of lime is insoluble in acetic acid; this is at times useful in distinguishing some of the unusual forms from phosphates. Aggregations of minute crystals or microscopic calculi are sometimes formed of very small dumb-bell or pyramidal crystals.

FIG. 98.



Oxalate of lime crystals. (Selected to show various forms.)

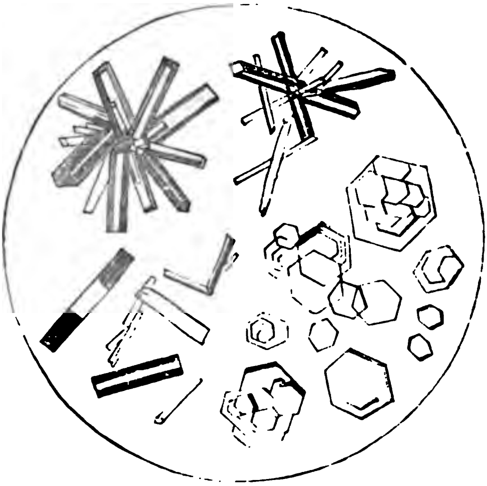
Other crystalline deposits are occasionally found in urine. *Carbonate of lime* occurs in little balls. *Cystine* is found in hexagonal tablets: it is dissolved by ammonia, and this may give on evaporation six-sided tablets or prismatic crystals. (See Fig. 94.) It is a rare deposit, but it is important on account of its forming certain calculi. *Tyrosine* occurs in needles. (See Fig. 69.) *Cholesterine* is a rare deposit, it occurs in scales. (See Fig. 73.) *Xanthine* is also extremely rare.

The clinical significance of amorphous and crystalline deposits is not so great as that of pus, blood, and tube casts.

Uric acid occurring habitually as a sediment, or even the persistence of *urates* as a deposit, indicates a derangement in the health, pointing to some error in the digestive or hepatic functions, and having perhaps some relation to the gouty diathesis (Lithiasis, Lithæmia). Very red urates are so frequently associated with liver disease as to be useful in directing attention to this organ. Uric acid is often found in cases of Bright's disease in the acute stages. The occasional occurrence of urates on the cooling of the urine has no real importance, and uric acid crystals may likewise appear, at a time, without any special significance. It is the habitual or excessive occurrence of these which is important. They sometimes appear at the crisis of fevers, etc.

Oxalate of lime, in like manner, when deposited habitually and excessively, and in urines of high specific gravity loaded with urea, is often found associated with a train of nervous and dyspeptic symptoms which have been grouped together and named "oxaluria," and are supposed by some to indicate an "oxalic acid diathesis." Oxalates are frequently present in the urine in nervous affections of various kinds. It must

FIG. 94.



Cystine. Hexagonal tablets and prisms from evaporated ammoniacal solution. (Roberts.)

be understood, however, that a few oxalates frequently appear in the urine apart from any obvious derangement of the health, and they occur habitually after eating rhubarb and some other articles of diet. The uric acid and the oxalic acid diathesis seem to have certain affinities; the former is certainly hereditary; it seems to be interchangeable with the latter in some members of the same family, and perhaps at different periods of the same person's history.

As associated with signs and symptoms of renal or vesical calculus and gravel, the appearance of either uric acid or oxalate of lime crystals is often of great importance in diagnosis and in guiding the treatment. These crystals, when associated with blood, tube casts, or pus, often point to the site and nature of the illness. The hedge-hog crystals of urate of soda may likewise be sources of renal, vesical, or urethral irritation, and may give rise to calculus.

Crystallized phosphate of lime has been supposed to indicate the existence of serious organic disease attended with waste of tissue (phthisis, diabetes, paralysis). It certainly is frequently met with in serious nervous affections.

The triple phosphates (ammonio-magnesian phosphates) have not much significance unless when detected in newly voided urine; they then indicate that a process of decomposition is going on within the bladder; they may likewise indicate the nature of vesical concretions in process of formation.

Persistent deposits of the amorphous earthy phosphates being associated with habitual alkalinity of the urine, are not unfrequently the index of a depressed state of health; they may also tend to vesical concretions. A similar remark applies to *carbonate of lime.*

Tyrosine crystals are occasionally found in typhus and other fevers, and especially in cases of acute yellow atrophy of the liver; the urine usually requires to be evaporated down to obtain these crystals. (See p. 430.) The clinical significance of *cystine* is not yet clearly made out; it may form the nucleus of a calculus.

SCHEME OF SYSTEMATIC QUALITATIVE ANALYSIS OF URINARY CALCULI (*Thudichum*).

Powder the calculus. Heat a small portion of the powder to redness on some platinum foil, and observe whether any residue is left which will not burn off.

A. In case it leaves a fixed residue, take a small portion of the original calculus, dissolve in concentrated nitric acid, evaporate to dryness on a water bath in a white porcelain evaporating dish; dip a glass rod into the strongest ammonia, and bring it near the residue in the dish, and observe whether a pink color is produced or not. ("Murexide test.")

I. A pink color is produced, proving that the calculus contains *uric acid;* observe whether a portion of the calculus melts on being heated.

a. It melts—

(1) And communicates a strong yellow color to the flame of a spirit lamp or Bunsen burner: *sodium urate.*

(2) And communicates a violet color to the flame, giving the potassium spectrum: *potassium urate.*

b. It does not melt; dissolve the residue left after ignition in a little dilute hydrochloric acid, add ammonia till alkaline, and then ammonium carbonate solution.

(1) A white precipitate falls: *calcium urate.*

(2) No precipitate; add some hydric sodic phosphate solution; a white crystalline precipitate falls: *magnesium urate.*

II. No pink color is produced. Observe whether a portion of the calculus melts on being heated strongly.

a. It melts (fusible calculus). Treat the residue with acetic acid; it dissolves; add to the solution ammonia in excess; a white crystalline precipitate falls: *ammonio-magnesium phosphate.* In case the melted residue is insoluble in acetic acid, treat with hydrochloric acid; it dissolves. Add to the solution ammonia; a white precipitate indicates *calcium phosphate.*

b. It does not melt; moisten the residue with water and test its reaction with litmus paper; it is not alkaline. Treat with hydrochloric acid, it dissolves without effervescence. Add to the solution ammonia in excess, white precipitate: *calcium phosphate.* Treat the calculus with acetic acid; it does not dissolve. Treat the residue after heating with acetic acid, it dissolves with effervescence: *calcium oxalate.* Treat the original calculus with acetic acid, it dissolves with effervescence: *calcium carbonate.*

B. The calculus on being heated does not leave a fixed residue. Treat a portion of the calculus with nitric acid, evaporate and expose to ammonia vapor as before. ("Murexide test.")

I. A pink color is developed.

a. Mix a portion of the powdered calculus with a little lime and moisten with a little water; ammonia is evolved and a red litmus paper suspended over the mass is turned blue: *ammonium urate.*

b. No ammonia: *uric acid.*

II. No pink color is developed.

a. But the nitric acid solution turns yellow as it is evaporated, and leaves a residue insoluble in potassium carbonate: *xanthine.*

b. The nitric acid solution turns dark brown and leaves a residue soluble in ammonia: *cystine.*

Bile in Urine

can often be recognized by the eye when present in any quantity. Moreover, when testing for albumen by nitric acid, the peculiar greenish reaction produced by bile usually attracts attention; indeed, bile in the urine may be tested for by using nitric acid by the "contact method:" dilution of the nitric acid with three volumes of water rather favors the distinctness with which the green reaction is brought out. Another way of applying this test with nitric acid consists in placing a drop or two of urine and a drop or two of strong nitric acid on adjacent parts of a white plate, and allowing the one to run into the other. The commingling of the fluids should be closely watched in good daylight, when a beautiful play of colors is observed—including brown, green, blue, violet, red, and yellow. Or a little acid may be dropped into the midst of some urine placed on a plate, or on a white sheet of note paper, when a similar reaction occurs.

The iodine test is also useful; it likewise develops a green reaction. Two or three drops of the tincture of iodine of the British Pharmacopœia cautiously floated on to the surface of the bilious urine in a test tube, by means of a pipette, bring out the green color. If the urine be very highly colored it may be diluted with water beforehand. The tincture of iodine may also be diluted with two volumes of rectified spirit, as too much iodine impairs the distinctness of the green color. These tests apply only to *bile pigment*. Rhubarb, santonine, and senna impart a color to the urine somewhat resembling the tinge of bile; the addition of liquor potassæ converts this into a fine red color.

A test for the *biliary acids* has been introduced, but it does not give reliable results as applied to a complex fluid like the urine. Two drachms of urine are introduced into a test tube, a small piece of loaf sugar is added, and a drachm of strong sulphuric acid is poured gently down the side of the glass; if the biliary acids are present, a deep purple color is produced at the line of junction; a brown instead of a purple color indicates their absence. (Pettenkofer's test.) This test, however, has not been found of much clinical value.

Of late an acidulated antiseptic solution of artificial peptones has been proposed by Dr. Oliver as a test for the bile acids or bile salts. For the details and precautions to be observed the reader is referred to Dr. Oliver's work. The test has not as yet been long in use.

The clinical significance of bile in the urine corresponds with that of jaundice. (See p. 425.) Its presence or absence assists in the differentiation of discolorations of the skin or of the conjunctiva due to other causes. It likewise seems occasionally to indicate an incipient jaundice before the tissues generally are affected, and its disappearance from the urine sometimes affords evidence that the attack is passing off, although the jaundice elsewhere may still remain very visible. The presence of bile pigment may serve to explain, so far, the existence of tube casts in urine, as already noticed under the heading of tube casts, or, at least, to give their presence a less serious significance. (See p. 482.)

Chlorides

are always present abundantly in normal urine. They are often diminished, or almost suppressed, in several febrile diseases, especially in pneumonia. The quantity may be roughly determined by adding a little of a strong solution of nitrate of silver to the urine, a few drops of strong nitric acid having been added previously. The denseness of the precipitate, or its relative abundance when the sediment falls down, serves to indicate the quantity; a sample of normal urine, treated in the same way, may be used as a basis of comparison. This precipitate of the chloride of silver (insoluble in nitric acid) is soluble in ammonia. Albumen, if present, must be separated before testing for chlorides, as it also is thrown down by nitrate of silver. Of course, an accurate quantitative estimation can be made by the usual chemical methods if desired.

The Estimation of Urea

contained in urine affords valuable data in certain physiological and pathological inquiries. It has been made out, however, that the quantity of nitrogen eliminated by the urine depends more on the quantity taken in as food than on anything else, so that if we aim at scientific precision, an analysis of the food taken is almost required to give value to the quantitative analysis of the urea. Albumen, if present, should be separated by boiling, before beginning the estimation of the urea. The natural excretion of urea may be quoted roughly at 500 grains per day for a male adult, or 3½ grains per pound weight of his body (33.18 grammes; or 0.5 gramme per 1 kilo. of body-weight).

The specific gravity of the urine (in the absence of sugar) usually gives a fair indication of the quantity of urea being excreted. Occasionally, by the rapid crystallization of nitrate of urea, on the addition of nitric acid to the cold urine, we have evidence of its presence in excess. For very accurate results, probably the best plan is to determine the *total nitrogen* by the ordinary processes followed by chemists in an ultimate organic analysis; but this, of course, is not available in clinical practice.

Two volumetric processes for the estimation of urea are employed, both of which afford moderately accurate results.

Liebig's Method is based on the principle of the precipitability of urea by mercuric nitrate, and further, on the circumstances that the white precipitate thereby produced is not decomposed, and, therefore, not turned yellow by carbonate of sodium. (This yellow color results from the formation of oxide of mercury, or basic nitrate of mercury, or carbonate of mercury.) It is necessary also to separate from the urine, before operating on it, the phosphates and sulphates, so that the urine requires first to be prepared by treating it with baryta-water and a solution of nitrate of barium. A further preliminary proceeding consists in determining the quantity of chloride of sodium present, as the reaction does not occur till the whole of the chloride of sodium is decomposed and converted into nitrate of sodium. This may be estimated by noticing the amount of mercurial solution added from the burette before the white precipitate begins to appear; or the amount may be determined more accurately by precipitation with silver. A further difficulty arises from the fact that this mercury process is only accurate when the proportion of the urea in solution amounts to two per cent., so that an allowance must be made in carrying out the process when the results indicate that more or less than this amount is actually present.

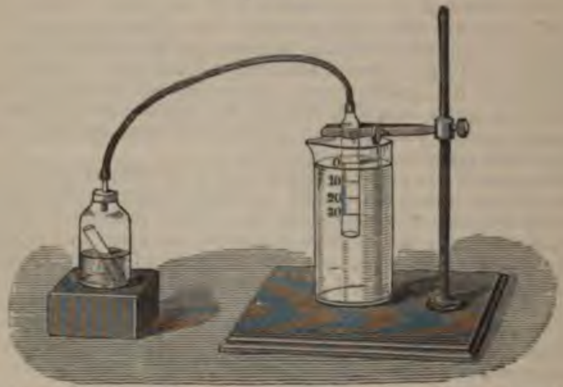
It is somewhat difficult to prepare accurately in its proper strength the solution of mercuric nitrate; indeed, the most satisfactory way is to dilute a solution of pure mercuric nitrate so as to correspond with a definite quantity of urea when this has been ascertained by precipitation from a pure solution of urea in water. The solution may also be purchased from certain makers. (Griffin, Bunhill Row, London.)

Details of Liebig's Method.—(Dr. Michael Foster, Watts' *Dictionary of Chemistry*, "Urine," vol. v. p. 966. London, 1874.) "*Prepared urine* (if albumen be present it must be separated by boiling, some urea will probably be lost). Two volumes of urine are mixed with one volume of a 'baryta mixture' (consisting of two volumes of baryta-water to one volume of a solution of barium nitrate, both saturated in the cold), and filtered. *Urea solution:* 2 grammes of pure urea are dissolved in water and the solution diluted to 100 c. c. —*Mercurial solution:* a concentrated solution of pure mercuric nitrate is diluted with four times its bulk of water. 10 c. c. of the urea solution are measured into a beaker, and the mercurial solution is slowly added from a burette as long as any precipitation takes place; a drop of the mixture is then let fall by a glass rod into a drop of a solution of sodic carbonate (say about 20 grains to the ounce) placed in a watch glass, or on a glass plate, over some black surface. If the precipitat which occurs on the mingling of the two drops does not become in a few seconds distinctly yellow, more of the mercurial solution must be added to the mixture in the beaker and the trial made again. As soon as a distinct yellow color appears (the shade being noticed by the observer in order to guide him afterward), the trial drops are returned into the beaker, and a little of the soda solution added until the mixture is only faintly acid. A drop is then again to be tried with the soda solution, and if the yellow color does not show itself, a small quantity of the mercurial solution must still be added to the mixture in the beaker and the trial made again. When the yellow color has been thus obtained, the total quantity of mercurial solution used is read off; it corresponds to 0.2 gramme urea. The mercurial solution itself is then diluted according to these results, so that 20 c.c. of it correspond to 10 grammes of the urea solution—*i. e.*, so that 10 c. c. correspond to 0.1 gramme urea. It is well not to add, at once, the whole of the water required, but to stop a little short of that and titrate again, since practically the degree of dilution required is rather less than that suggested by calculation.

"*Method.*—Of the *prepared* urine 15 c. c. (corresponding to 10 c. c. of the original urine) are poured out into a beaker or flask, and the mercurial solution is added until the yellow reaction, as described above, is obtained; the mixture is also in the same way reduced in acidity and trial made again. The quantity of mercurial solution used will give the amount of urea in the 10 c. c. of urine. Unfortunately the reaction is exact only for fluids containing 2 per cent. of urea; its appearance is permature when more, and is delayed when less than that percentage is present. If the prepared urine contains an *excess* of urea, double its volume of the mercurial solution will have been used and yet no reaction set in. Hence if, on arriving at this point, 1 c. c. of distilled water be added to the mixture for every additional 2 c. c. of the mercurial solution employed, the proportion of urea will be maintained at 2 per cent. and the final result will be correct. Thus if, after the addition of 30 c. c. of mercurial solution to 15 c. c. of the prepared urine the reaction is not seen, 1 c. c. of distilled water is added and the process continued. Supposing the reaction finally sets in when 10 c. c. more, or 40 c. c. in all, of the mercurial solution have been used, the 5 c. c of distilled water, which have been also added, will bring up the original 15 c. c. of urine to 20 c. c.; the 40 c. c. of mercurial solution will have been employed on a fluid containing 2 per cent. of urea.

"If the prepared urine contains *less* than 2 per cent. of urea an approximate correction may be made by subtracting 0.1 c. c. from every 5 c. c. of the mercurial solution that is run short of the normal 30 c. c. Thus, if with 15 c. c. of prepared urine the yellow color is struck on using 20 c. c. of the mercurial solution, 0.2 c. c. ($30 - 20 = 5 \times 2$) are deducted, and, therefore, 19.8 c. c. taken as the correct result. A further correction must be made for chloride of sodium, the presence of which delays the reaction. We may make an approximate correction by deducting from the quantity of mercurial solution employed 1.6 c. c.—2.5 c. c., according to the quantity of chloride of sodium present. Or we may first remove the chloride. To 15 c. c. of prepared urine one or two drops of solution of neutral chromate of potash are added, and a solution of nitrate of silver dropped in from a burette, until the appearance of the red chromate of silver indicates that the whole of the chloride has been thrown down; the mercurial solution can then be at once used without removing the silver precipitate. The reduction in the percentage of urea by the addition of the silver solution must, of course, be taken into account. Or two portions of prepared urine may be taken of 15 c. c. each. One is neutralized with nitric acid, the mercurial solution added, and the point marked at which a permanent precipitate (a distinct cloud, not a mere opalescence) is produced. The other is titrated in the usual way. The number of c. c. employed in the latter, minus those employed in the former operation, will give the real quantity of urea.

FIG. 95.



Apjohn's apparatus for the estimation of urea by the hypobromite of sodium solution.

"It must be remembered that other nitrogenous bodies, creatinine, allantoin, etc., are precipitated by the mercurial solution in the same way as urea."

Hypo-bromite of Sodium Process for Estimating Urea.—Davy's process (by hypo-chlorite of sodium) has been modified and adapted for clinical purposes by Esbach, of Paris, Russell and West, and Apjohn. The process consists in estimating the quantity of nitrogen given off when a solution of urea is mixed with a hypo-bromite solution. This last-named solution is very readily changed by keeping, and so must be made fresh. It is composed of 100 grammes of caustic soda, 250 c. c. of water, and 25 c.c. of bromine, all shaken up together. (Of course the soda solution can be kept and the bromine added in proper proportion when wanted, so as to be used fresh.) The following is the description of Apjohn's process (*Chemical News*, Jan. 22, 1875). The instruments are such as may be found in any laboratory; they are: (1) A glass measuring tube of about a foot in length, drawn out at the end, which will be uppermost when the tube is used, like a Mohr's burette, and sub-divided into 30 parts of equal capacity, the aggregate volume of which is 55 c. c. (2) A small wide-mouthed gas bottle of about 60 c.c. capacity. (3) A short test tube of about 10 c. c. capacity, of such a height that when introduced into the gas bottle it will stand within it in a slightly inclined position. (See Fig. 95.) [Various other adaptations of this method, and special forms of apparatus, are in use for clinical work.]

The following are the arrangements for combining the apparatus and working an experiment: The graduated tube, held in a clamp attached to a retort stand, is depressed into a glass cylinder nearly filled with water until the zero mark, which is near the upper end, exactly coincides with the surface of the water. Fifteen c. c. of the hypobromite solution having been poured into the flask, the test-tube containing the urine is introduced by means of forceps, care being taken that none of its contents shall spill into the hypo-bromite. The flask is now closed with a very accurately fitting India-rubber stopper, perforated with a hole, in which is inserted a short piece of glass tubing open at both ends, and is then connected with the measuring tube by means of a piece of elastic tubing. It is now inclined so as to allow the urine to mix with the hypo-bromite. Effervescence at once commences, and as it proceeds the measuring tube is gradually raised, so as to relieve the disengaged nitrogen from the hydrostatic pressure. The flask is shaken a few times, and when the reaction is completely over, the apparatus is left for a few minutes until it has acquired the temperature of the room in which the experiment is performed. Another exact levelling of the measuring tube is made, and the number of the division corresponding to the volume of the developed nitrogen is read off. Fifty-five c.c. of the nitrogen correspond to 0.15 gramme of urea, so that a single division corresponds to 0.005 gramme of urea. If, therefore, we use 5 c.c. of urine, each measure of the nitrogen evolved will correspond to 0.1 per cent. of urea (or 0.44 grain per fluid-ounce).

Variations occur, of course, in the measured gas from the effect of changes in the temperature and barometric pressure, but the advocates of this method allege that these are inconsiderable in ordinary clinical work. Other nitrogenous principles are also included with the urea in the estimation by this method. Albumen, if present, must be separated beforehand.

Of course the total urine passed must be known, in order to estimate the total amount of urea excreted.

COMPLAINTS BY PATIENTS REGARDING URINARY SYMPTOMS, ETC.

Patients sometimes call attention to alterations in the appearance of their urine, of which it is important to be able to form some judgment. In the section on the "Obvious Characteristics of Urine" these have been considered.

Frequency and pain in micturition are often complained of by patients, either with or without the consciousness of some connection between these symptoms and other urinary disorders. The student of clinical medicine must never forget that these are important symptoms of surgical as well as medical diseases. Frequency of micturition may be due to stricture of the urethra, and it is very common in elderly men with enlarged prostate; in women it occurs in connection with uterine irritation, and with displacements of the womb. Increased frequency in micturition may be due simply to irritability of the urinary organs, but it is also often of value in calling attention to, or marking the date of, an actual increase in the secretion of urine, as in diabetes, and in certain forms of chronic renal disease. In the early stage of both of these the patient may find that he has begun to get up at night to pass water, and although he may attribute this to his being thirsty, and to his drinking more water than usual, the thirst and the increased urine may be due to the same cause. Frequency and pain in micturition often occur in nephritis, strangury, cystitis, and also from calculus in the kidney, ureter, or bladder. Scalding or pain in making water is often complained of in the febrile state; this is associated with the secretion of a highly acid and concentrated urine; it is also often due to gritty matter (gravel) in the urine: and to irritation of the urethra from gonorrhœa. In women it is not unfrequently due to small vascular growths at the orifice of the meatus urinarius, and occasionally to prolapsus of the urethra itself: these are very apt to escape attention, as their situation makes it a matter of much delicacy to examine the parts thoroughly. In male children the pain in micturition may be due to the irritation of a phimosis. Fissure of the anus, and other affections of the rectum, or disease in its neighborhood, often give rise to pain in passing water. These various causes may have to be considered and decided on by an ocular, or surgical, or instrumental examination of the meatus, the urethra, the bladder, the womb, or the rectum. Not unfrequently the presence of blood in the urine, its color, and the manner of its coming, whether diffused in the urine or appearing as a few drops at the end of micturition, may assist the diagnosis. The presence of pus likewise in the urine, and the character and situation of the pain, are of great value in the study of such cases. (See "Blood and Pus," pp. 470 and 474.) Any supposed cause of the painful attack, such as injuries, or special exertions from riding, jolting, etc., should be carefully inquired into. (See also the section on "Paralysis of the Bladder," p. 229.)

The following general treatises may be referred to: Roberts (Sir William), Practical Treatise on Urinary and Renal Disease, 4th edition, London, 1885.—Dickinson, Diseases of the Kidney and Urinary

Derangements, Part I., Diabetes (1875); Part II., Albuminuria (1877); Part III., Miscellaneous Affections of the Kidneys and Urine (1885), London, 1875-85.—Ralfe, Diseases of the Kidneys and Urinary Derangements, London, 1885.—Thompson (Sir Henry), Clinical Lectures on Diseases of the Urinary Organs, 6th edition, London, 1882.—Morris, Surgical Diseases of the Kidney, London, 1886.—Guyon et Bazy, Atlas des Maladies des Voies Urinaires, Paris, 1886.

For urine testing, in addition to general treatises given above: Thudichum, Treatise on the Pathology of the Urine, including a Complete Guide to its Analysis, 2d edition, London, 1877.—Ralfe, Clinical Chemistry, London, 1883.—Johnson (Geo.), Various Modes of Testing for Albumen and Sugar in the Urine, London, 1884.—Oliver (G.), Bedside Urine Testing, 3d edition, London, 1885.—MacMunn, The Spectroscope in Medicine, London, 1880.—Neubauer and Vogel, Guide to the Qualitative and Quantitative Analysis of the Urine, translated for the New Sydenham Society, London, 1865; for the recent views of these writers reference must be made to subsequent editions in German (and in French translations) of this standard work. —Salkowski und Leube, Die Lehre vom Harn, Berlin, 1882.—Puhlmann, Die Chemisch-Microscopische Untersuchung des Harns, 3te Afl., Berlin, 1885 —Works on organic chemistry must also be consulted for special purposes—*e. g.*, Hoppe-Seyler, Physiologische Chemie, Berlin, 1877–81.—Charles, Physiological and Pathological Chemistry, London, 1884.

For illustrations of urinary deposits: Beale, Kidney Diseases, Urinary Deposits, and Calculous Disorders, 3d edition, London, 1869; his Plates are also published separately, 2d edition, London, 1869.—Whittaker, The Students' Primer on the Urine (with etchings), London, 1880.

Special treatises must also be referred to for particular diseases: Pavy, Nature and Treatment of Diabetes, 2d edition, London, 1869. —Frerichs, Ueber den Diabetes, Berlin, 1884.—Johnson (Geo.), Lectures on Bright's Disease, London, 1873.—Grainger Stewart, Practical Treatise on Bright's Diseases of the Kidney, 2d edition, Edinburgh, 1871.—Monuenoux, Les Matières grasses dans l'Urine, 2 vols., Paris, 1884; this work gives an elaborate account of chyluria and other rare conditions.—Senator, Albuminuria in Health and Disease, translated for New Sydenham Society, London, 1884.

The following great works have a permanent value: Bright, Reports of Medical Cases, vol. i., London, 1827.—Rayer, Traité des Maladies des Reins (3 vols., with large folio Atlas), Paris, 1837-41.

CHAPTER XIV.

SYMPTOMS CONNECTED WITH THE MALE GENERATIVE ORGANS.

DISTURBANCES of the generative organs in the male come, for the most part, under the notice of surgeons, and reference must be made to surgical treatises or to special works for details on this subject. Complaints, however, are sometimes made to physicians also, concerning impaired or disordered functions in these parts, and various nervous diseases arise from sexual excesses and abuses. The chief complaints met with in medical practice are connected with impotence, seminal discharges, and masturbation.

Impotence supervenes in the course of paralysis, and is very common in those forms of spinal paralysis which involve the bladder and rectum. Its occurrence in such cases is not due directly to sexual excesses, even although the paralysis on which it depends may have been brought about in this way. Premature impotence, however, apart from other paralysis, is apt to arise at a comparatively early age in those who have erred in this respect. In locomotor ataxy there is sometimes an impairment of this function: it has been alleged that this disease differs from other forms of spinal paralysis in this respect, and that there may be even an excessive aptitude for frequent indulgence: this, however, seems to have been greatly overstated, although it may be an *early* symptom in a few cases. Locomotor ataxy is well known to depend not unfrequently on sexual excess in the case of men.

Various debilitating diseases, diabetes for example, are characterized by impotence as part, apparently, of the general debility. This is much less marked, or notably absent, in some other exhausting diseases, and especially in phthisis.

Impotence is sometimes imagined or dreaded by patients without there being any good grounds for the opinion; and the idea sometimes seizes possession of the mind in such a form as to constitute a species of insanity. Prolonged brooding on such subjects, and the reading of quackish, or even of legitimate, medical dissertations on the consequences of musturbation, etc., are apt in certain minds to foster the delusion and to upset the calmness of reason. If the organs seem sound on examination, and if there continue to be indications of functional activity in them, we can reassure our patients. Points of importance in the character of the impotence, such as the following, have sometimes to be determined in view of the treatment: The absence of sexual desire; more or less anæsthesia of the glans penis; imperfection or weakness in the erection, from defect in the muscles concerned, or from other causes; premature emission.

Priapism (excessive or permanent erection) is an occasional symptom in spinal paralysis (myelitis especially), but no indications of special value can be drawn from its presence. It has been specially noted in cases of injury to the cervical and lumbar regions of the spine. It has been reported to occur at times in cerebral cases also.

Masturbation is credited with the production of an untold number of ills, both bodily and mental. While the practice is highly pernicious, especially if long continued and frequently repeated, it is probable that its influence has been overstated, especially in connection with the causation of insanity, although, no doubt, it sometimes leads to mental disorder. (See p. 316.) The possibility of excessive, or uncontrollable masturbation, like excessive drunkenness, being sometimes due to the insane tendency of the patient, instead of the cause of the insanity, must be borne in mind. The frequent practice of masturbation, however, may produce various nervous diseases, just as we find that excessive sexual indulgence, even in the married state, may do; and the great frequency of the opportunities presented to the masturbator in gratifying his desire, accounts probably for part of the special evils which arise in his case. Excess in venery, which is often carried to an extreme by some who are newly married, and occasionally continued by them to an unreasonable extent, may give rise to palpitations, pulsation in the epigastrium, debility, dilatation of the pupils, and nervousness in various forms; among the more serious forms of disorder, due to the various forms of excess, may be named spinal paralysis, locomotor ataxy, and convulsions. Mental disorder is supposed to arise at times from this cause. (See p. 315.)

It should be remembered, in presence of anomalous nervous symptoms, that even very young children sometimes practise masturbation, and this may arise from some mechanical irritation in the parts, or from less obvious causes (such as diabetes) connected with the organs. In boys, pulsation at the epigastrium and dilatation of the pupils, a languid frame of mind and other nervous disturbances may arise from this cause.

Seminal discharges may likewise assume a greatly exaggerated importance in the minds of patients from the pernicious influence of quack literature, or the reading of medical books. The terrors held over their patients by quacks in connection with this have a disastrous influence on many persons. A certain frequency of these emissions is natural to young men who lead a chaste life, and their frequency is often increased by studious or sedentary habits, and the attendant dyspepsia and constipation so common in such persons. A course of prurient reading also favors this unnatural frequency. When the emissions occur every night, or twice or thrice a week, the condition is certainly unnatural (although not necessarily alarming), and this is the more certain if the discharges occur without the patient being aware of their coming away, or if they occur during the day, or without any previous erection. Patients sometimes complain very much of this symptom, and allege the frequent passing of semen in their urine. This does occur at times, but the milkiness and turbidity complained of are not unfrequently due merely to phosphatic deposits occurring in the alkaline urine within the bladder. Chemical and microscopic tests can set such doubts at rest. Another form of discharge complained of consists of a little clear glairy fluid, like white of egg frequently or constantly exuding from the urethra. This is due to prostatic or some other than the seminal secretion, and has not much significance, although it is increased by the same influences which favor frequent seminal emissions. When from the account given, or from the frequent or habitual presence of spermatozoa in the urine, we are satisfied of the existence of a morbid condition, we must inquire whether any unnatural excitation of the parts has been caused by masturbation, a practice which patients, as a rule, do not readily confess. The general health and habits, the state of the stomach and bowels, and the use of stimulating food or drink late at night must be inquired into.

This condition is often found to be associated with a most distressed state of mind, want of energy, depression of spirits, with perhaps actual weakness and incapacity for work; the patients seem often to foster the idea of their dreadful condition and refuse all hope and consolation. This state is often associated with other abnormalities, particularly frequent alkalinity of the urine, or the deposit of oxalates with a high specific gravity of the urine; it disappears with improved health and active occupation.

CHAPTER XV.

DISORDERS OF THE FEMALE ORGANS, AND THEIR RELATIONS TO THE GENERAL HEALTH.

MENSTRUATION AND ITS DISORDERS.

STUDENTS often experience considerable difficulty at first in conducting inquiries on these subjects. What are the points regarding which information is to be elicited? How are the questions to be put? The inquiry can always be conducted with such refinement as will not offend any proper delicacy of feeling; on the other hand an unfavorable impression may readily be conveyed to the mind of the patient by the form or mode of putting a question.

In many cases a few general questions are all that is necessary. In hospital practice, where the cases are fully recorded, inquiries should always be made as to these functions; but in private practice it is well to abstain unless there is a clear necessity. When the patients are young, inquiries should, when possible, be made through the parents; at all events the subject should be introduced through them.

It is well to lead up to the subject, or to introduce it with a special bearing upon the symptoms complained of. Thus one question may introduce another. Having asked if the bowels are "regular," there may next come, "And are you regular in your own health?" "Not too often or too much at a time?" Or if some special pain or deranged function is complained of, the subject may be introduced by asking, "Do you suffer in this way more at the times you are unwell than between times?"—and then follow the further questions. It is well even at times to offer some such explanation as "Symptoms such as you have are often dependent upon derangements of your own health." Women do not understand the term "menstruation." It is known to them as their "courses" or "periods." They speak of "changing" or "altering," of "being poorly" or "unwell," of being "regular" or "not regular;" they will say "I have seen nothing for such or such a time," or "My own has left me."

Normal Menstruation.—The functional activity of the female generative organs is normally manifested by the periodic discharge of blood, which constitutes what is termed menstruation. The points regarding which inquiry is to be made, or, in other words, the evidence by which the healthy performance of the function is to be determined are: (1) The regularity of the return; (2) the duration of the flow; (3) the quantity of the discharge; and (4) the amount of local or general disturbance which accompanies it. There is an average standard which is taken as the guide, but each case must also be judged by the individual habit.

(1) The interval between the first day of menstruation and its reappearance at the next period is generally reckoned as twenty-eight days or four weeks. The time, however, is not fixed or definite, but varies in different individuals, and even in the same person. Normally it oscillates between certain limits, which may be taken as from twenty-five to thirty-two days; and the average for one woman may be twenty-seven, for another twenty-nine. (2) The duration of the discharge likewise varies in different individuals—from two, or even one day, to eight days. (3) Some lose but little blood, others a considerable quantity. (4) Some suffer no inconvenience, whilst others have considerable local pain. The individual habit, therefore, must always be ascertained and taken as the criterion of healthy function, rather than any general standard. What in one person may be normal may in another be evidence of excess or defect.

It is not sufficient to recive a simple affirmative reply to the question, "Are you quite regular?" Many women will say they are, when afterward they will be found to have excess either in time or in quantity, or in both. It is necessary therefore to follow up by "Not oftener than you used to be? not more at a time than you always had?" Excess in duration is readily noticed; but there is one source of fallacy which must be guarded against. A colored discharge may continue for a week or more, yet the actual hemorrhage may have lasted only four or five days: the continuance of the discharge resulting from the retention or breaking down of small clots, may lead the patient to believe she is still menstruating. In such a case a change in color as well as quantity will indicate the character; from being free and bright-colored it will have become scanty and of a chocolate color, or like coffee-grounds. As to excess in quantity it must to a great extent be reckoned by comparison with what the woman has been accustomed to. What one person finds an ordinary amount may in another be evidence of an injurious excess. A common way of estimating the quantity is by the increased number of napkins the patient requires in twenty-four hours. The flow also may at times be so profuse that the patient will say that napkins are of little use. Large clots are also evidence of excess; but small shreddy clots are common even in healthy menstruation.

Various derangements of menstruation have received distinct terms in medical nosology. Its non-appearance at the usual age, or its suppression after its establishment, is known as *amenorrhœa;* when accompanied by excessive pain it is termed *dysmenorrhœa;* when in excess, *menorrhagia.* It cannot, however, be too firmly impressed upon the mind that these terms represent symptoms only, and not actual diseases; and however useful for the purpose of study or description these names may be, they do not represent any actual state which will determine treatment. Amenorrhœa may in one case be the result of bad health, and in another may be consistent with a robust constitution. Menstruation may regularly recur, and yet the constitution may be steadily becoming undermined from the strain thrown upon it in the developmental processes which are taking place. It must always be remembered that menstruation is but part of the general process of the development of reproductive life, and that the latter is not completed when the menstrual discharge has once regularly been established, but continues for some years; in fact it may be considered incomplete in many cases until the twenty-second year. Whatever, therefore, the nature of the prominent symptom may be, the opinion to be formed and the treatment to be adopted will be determined less by that symptom than by the constitutional character or habit of body of the patient, and by the nature of the disturbance of the general functions.

Primitive amenorrhœa (emansio mensium), where the flow has never taken place. The inquiries should be made to elucidate the following points:

(1) The age and general development. In this country menstruation first shows itself from the thirteenth to the sixteenth year. But age is not a sure criterion, the general development of the body must be associated with it. (2) The previous history. A severe illness about the age of puberty may retard menstruation. (3) What is the condition of the general health? Is it impaired? then the amenorrhœa is but part of the deranged condition—the effect, not the cause. If the health is good, and the patient is not suffering, and her configuration is womanly, there remains the question of defective development of the uterus (infantile uterus), or defec-

tive formation of the generative organs (absence of ovaries, or uterus, or vagina). The diagnosis in the latter case can only be absolutely made by a physical examination—a recourse, however, only to be had under very special circumstances.

Internal evidence of functional activity, without discharge, is sometimes present in the periodical recurrence of lumbar and pelvic pains, malaise, and headaches—symptoms known as the *menstrual molimen*. At times epistaxis or other hemorrhages may occur. The regular periodicity is the all-important character of such symptoms. They are evidence of ovarian activity, and the presence of these organs is all that can be inferred from them. The absence of such symptoms, however, is no evidence of want of these organs. The occurrence of these symptoms with increasing severity, and the appearance of a tumor rising out of the pelvis, are diagnostic of retained secretion (imperforate hymen or occlusion of os, etc.). In all cases where the menstrual molimen has occurred the abdomen should be examined for such a tumor.

Menstruation having appeared, is the health suffering from the strain of the developmental process?—Amenorrhœa usually causes much anxiety on the part of parents for the health of their daughters, but when once menstruation has occurred it is thought the danger is passed. We have already observed, however, that the strain of reproductive development continues for some years after this event, and the health may suffer from this cause, especially under the influence of bodily or mental overwork. The symptoms are very varied, and often indefinite, and may affect the nervous or digestive systems, or the blood-making function. With each menstrual period there is the return of the lassitude and inaptitude for work, change in disposition, and headaches, or the derangements of the alimentary canal, or the localized pains from which many girls suffer. As the patient is "quite regular," it is supposed "it will all come right," especially as at first the system rallies between times, and she regains health. But gradually, by the accumulation of small effects, she recovers less and less till finally the symptoms are constant. Anæmia and chlorosis are very common between the seventeenth and twentieth year.

The health may thus suffer notwithstanding perfect regularity in the menstruation. Frequently, however, this function is also deranged. The character of the derangement depends to a large extent upon the constitutional temperament. In the relaxed or strumous habit there is generally excess in frequency or amount, with copious leucorrhœa; in others the tendency is to scanty or irregular menstruation; and in the highly nervous temperament, or when there is a hereditary history of gout, the ovarian pains, spinal irritation, or cerebral suffering predominate.

Suppression of Menstruation or Secondary Amenorrhœa—The inquiries should be guided by the following list of causes: (1) Pregnancy (see signs of pregnancy, p. 521). (2) Influences affecting the system at a catamenial period (cold, mental emotions, and exanthematous diseases). (3) Constitutional causes (after fevers and acute diseases, sedentary and confined occupations, overwork or over-pressure in education, change of residence, long-continued mental anxiety, anæmia, chlorosis, continued drain on the system, tuberculosis). (4) The menopause (see p. 516). (5) Local causes (pelvic inflammations, acquired uterine or vaginal atresia, imperfect involution after abortions or delivery at full time; more rarely diseases of the ovaries and displacements of the uterus).

Menorrhagia is excess of the menstrual flow. Hemorrhage from the uterus, not menstrual, is termed "Metrorrhagia;" but it is difficult at times to determine whether the discharge is of the one nature or the other. The distinction is nevertheless important. The first point to determine is the character of the excess, compared with the ordinary standard and the individual habit already referred to. The excess may be in quantity, or in duration, or in frequency of return, or in any two or all of these combined. Whatever the change, maintenance of regular periodicity, both in duration and the return, favors the idea of a truly menstrual nature, as distinguished from hemorrhage.

The special cause of the menorrhagia must be determined by the previous history, the general constitutional condition, and the local examination. (1) *The previous history.* Menorrhagia is frequent after abortions, or on the return of the catamenia after nursing, especially when lactation has been prolonged. It is common shortly after marriage; at times menstruation will then be suppressed for one or two periods and return in excess—the first being supposed to be due to a miscarriage. Change of residence or mode of life is at times the cause. Profuse menstruation sometimes follows acute fevers and pelvic inflammatory affections. (2) *The general condition.* It may be caused by whatever impairs the general health, such as sedentary occupations, and over-pressure in work or education. In young girls, especially those of the strumous, or so-called phlegmatic temperament, menorrhagia is often present; also, at all periods of life, from a sluggish abdomen; constipation, hepatic derangement, loaded urine, a full plethoric habit of body, or rheumatic or gouty constitutions are frequently associated with the affection. Altered conditions of the blood, associated with Bright's disease, purpura, and the like, give rise to menorrhagia; but in simple anæmia it is necessary to determine by the history whether the anæmia is the cause or the effect. (3) *Local examination.* It is often a question whether in a given case a local examination is necessary or not. If the periodicity is well maintained, a sufficient constitutional cause having been found, and no other marked symptom of uterine disease existing, then it is not necessary at first. But if treatment has already failed, if the periodicity is not well observed, and if there has been marked flooding or metrorrhagia rather than menorrhagia, and if any other symptoms suggestive of organic changes or of displacement are present, then an examination should be insisted upon. The local conditions which may give rise to menorrhagia or hemorrhage from the uterus include nearly all uterine affections. The following list contains the more common: Polypi and fibroid tumors, malignant diseases of the uterus, endometritis with granulations, chronic inflammation and hypertrophy, retroversion and prolapsus, congestion of the ovaries, retained products of conception.

Dysmenorrhœa.—A certain degree of pain and discomfort is felt during a menstrual period by the majority of women, but at times it becomes so severe as to compel them to seek advice. Cases of this description may all be classed under the heading dysmenorrhœa; but it is evident that the term is thus used in a very general sense, and is equivalent to menstrual suffering when it becomes more than ordinarily severe. Many different conditions have in this way been associated together, with the inevitable result of much confusion. No other subject, perhaps, has given rise to a greater diversity of opinion. "It is manifest that the most discordant views exist amongst the very highest authorities, and on almost every point." Keeping clear of all disputed points, as regards causation, the subject will be here presented from its clinical aspects.

From the mass of cases of acute menstrual suffering, it is possible to disassociate a large class presenting a well-marked train of symptoms, to which the term dysmenorrhœa proper may be applied. By some writers the name "spasmodic dysmenorrhœa" has been used to designate this class, but it is objectionable as implying a theory which may or may not be true, and at least has been disputed.

In dysmenorrhœa proper (so-called "spasmodic") there is acute pain associated with the beginning of the period, coming on very generally before the discharge makes its appearance, or synchronously with it; continuing for one or at most two days, but often only for a few hours; leaving behind it uneasiness and prostration probably for several days. The pain is referred to the hypogastrium and sacral regions, sometimes running down the thighs. It unfits the patient for her duties, generally compels her to lie down, but prevents her from lying quietly, making her "roll about" and moan or cry out. Often it gives rise to reflex symptoms such as headaches, retching, and vomiting.

The distinguishing features will thus be seen to be—(1) The limitation of the pain to the beginning of the period. If there is in a case acute suffering after the second or third day, it will generally be found to be different in character, more continuous and steady, and less paroxysmal. It is probably due to some condition superimposed upon the other, such as a general neuralgic or hyperæsthetic state. There are some cases of dysmenorrhœa where there is no suffering till after the first or second day; the pain may then be paroxysmal, but the cause is evidently different from that of dysmenorrhœa proper. (2) The paroxysmal character with the inability to lie quietly is distinctive from a pain of an inflammatory nature which fixes the patient down, is aggravated by movement, and may even prevent her breathing with freedom. (3) The seat of pain, central and diffused equally all round, is distinctive from some cases where the pain may be present before the discharge and relieved by it, but where it is confined to one side, or both sides, but distinctly lateral. Here the ovaries are evidently the seat of suffering.

The typical form of dysmenorrhœa above described is now fully recognized as associated with some condition of the internal os uteri, which is always relieved temporarily, and in many cases permanently, by dilatation. Whether this condition is one of increased sensitiveness, of spasm, or a congenital or acquired stricture giving rise to obstruction cannot be here discussed. Whilst this form of dysmenorrhœa is frequently to be found pure and simple, yet it is very liable to become complicated with one or more of other elements, which of themselves may give rise to very acute menstrual suffering. Two or more conditions are therefore often found to coexist, and must be as far as possible differentiated. Of these conditions the chief are—(1) A general state of nerve exhaustion, or a neuralgic condition associated with anæmia, gout, or rheumatism. (2) Pelvic inflammation—the uterus, the ovaries, the Fallopian tubes, or the peri-uterine tissues. (3) Polypi or tumors of the uterus or cervix. (4) Flexions of the uterus. (5) The desquamation of the uterine mucous membrane in shreds or casts (Membranous dysmenorrhœa).

"THE CHANGE OF LIFE:" THE CLIMACTERIC PERIOD: THE MENOPAUSE.—By these terms is denoted the end of reproductive life in the female, as indicated by the cessation of menstruation. This period is marked by a predisposition to both local and general derangements of health. It occurs between the fortieth and fiftieth years.

Local Derangements.—The manner of the cessation of menstruation varies. It may cease suddenly or gradually—the intervals becoming longer and more irregular, and the quantity variable. This period of irregularity is spoken of as "the dodging time." Frequently the change is indicated by excess of menstruation, both in quantity and frequency. The menorrhagia of this period should not be overlooked, but carefully investigated, especially if continuing past the ordinary age. Hemorrhage returning after a lengthened interval, and presenting no definite periodicity, is always suspicious and calls for an examination.

General Derangements.—The nervous, vascular, and digestive systems frequently suffer. One of the most common complaints consists in flushings, chiefly of the head and face, and sometimes felt over the whole body. It is associated with a hot, bursting feeling in the skin, and is often relieved by perspiration. A dryness of the skin, or want of ordinary perspiration, is frequently associated with flushings. A peculiar headache affecting the occipital region, and extending to the neck, is often experienced. It has long been recognized that there is at this age a special predisposition to mental derangements. Rheumatic and gouty affections may also manifest themselves, although previously absent. The digestive system tends to become sluggish and impaired.

CLINICAL VALUE OF SPECIAL PELVIC SYMPTOMS.

Leucorrhœa.—The mucous membrane and glands of the genital tract secrete a fluid sufficient to keep the opposing surfaces moist, but under ordinary circumstances it is not manifest externally. In unhealthy conditions it escapes externally, constituting what is termed leucorrhœa, or popularly "the whites." A physiological degree of leucorrhœa is often present just before or after menstruation, and must not be confounded with the pathological state. A considerable amount of white discharge is met with at times during pregnancy. In young girls leucorrhœa is common, and is often regarded as the cause of the weakness. It is really the effect, and may be met with in debilitated constitutions, especially the strumous and phthisical. The absence of any other uterine symptom except amenorrhœa, or scanty and irregular secretion, will point to the truly constitutional nature. Any bad hygienic influences, and certain occupations, such as the use of the sewing machine, may lead to this form of the affection.

Leucorrhœa is an almost constant attendant in all uterine affections, but usually other symptoms are associated therewith. In such cases a careful examination should be made when possible, before treating in routine fashion the prominent symptom.

The secretion may come from the uterus, the vagina, or from both. In the former case it may be seen by means of the speculum escaping from the os, clear and glairy, like the white of egg, becoming thick and opaque in the vagina. The microscope (which, however, is rarely necessary) will also detect the source by the character of the epithelial cells—round or columnar from the uterine cavity, and tessellated from the vagina. The discharge may be purulent in character, but no special inference can be derived from this condition; the diagnosis must be based on other considerations. A mucous discharge may be present, and even abundant, without the patient's being conscious of it, either from inattention or from its escaping only during micturition.

Children at all ages are liable to a so-called "infantile leucorrhœa," which, however, arises from the vulva only, and is in no way related to the discharge found in adults. It is often very obstinate, and is dependent upon a depraved constitutional state.

Watery Discharges.—Associated with leucorrhœa or occurring alone, the discharge may be watery in character, sometimes greenish in color, at others pink or tinged with blood. A greenish watery discharge sometimes follows parturition, and is associated with imperfect involution of the uterus. If there is any cause for suspecting pregnancy, it may be the rare affection termed *hydrorrhœa gravidarum*, or a symptom of the cystic (hydatidiform) degeneration of the ovum. Several cases are on record where watery discharges formed the sole symptom of a uterine polypus; more commonly such tumors are associated with hemorrhages. In all cases the odor is sufficient to distinguish between a watery discharge and an involuntary escape of the urine. Met with under other circumstances, and especially when pink or frequently bloody, the usual cause is malignant disease. In sarcoma of the uterus, and when a fibroid tumor is undergoing degenerative changes, copious watery discharges sometimes occur.

Pain.—The significance of this symptom, apart from the revelations of a local examination, must be determined by the character of the pain, its exact seat, and the time of recurrence or exacerbation, considered in connection with the apparent cause.

(1) The character is very variable, dull and constant, sharp, shooting, hot, throbbing, etc. One term frequently used is "down bearing;" as used in general it is utterly indefinite. It is employed for the feeling of fulness or distention; or it may be simply weight, or the sensation that something is trying to press out at the "front passage." It is met with not only in uterine affections, but also when the bladder alone is irritable, or it may arise from hemorrhoids.

(2) The exact seat of the pain must be noted—whether limited to a spot or diffused over a limited area. Thus pain is often described as in the side—this may be near the crest of the ilium or in the inguinal region. Again, a pain in the latter part may be general or indefinite, or a painful spot can perhaps be exactly localized and covered with two fingers. By careful localization affections of special nerves can be made out. The pain of cancer of the uterus is frequently localized immediately behind the pubes, gnawing or grinding in character and marked by nocturnal exacerbations. Dorsal, lumbar, and sacral pains have no special pathognomonic significance—they are common to all pelvic affections.

(3) Any periodicity in the character of the pain must be noted. It is often marked in neuralgic affections—coming on at a fixed hour. Nocturnal exacerbations are often well marked in malignant disease of the uterus, and are occasionally met with in pelvic inflammations and abscesses.

(4) An important question to determine is whether pain is menstrual in origin. If recurring only with the catamenial,

lasting for a short time after, and disappearing till the next period, the question is simple enough. But a pain such as backache may be constant and yet menstrual. In such a case the history will show that at first the pain occurred only with menstruation, but gradually increasing (by accumulation of effects) had become permanent, though still subject to exacerbations at a monthly period. A menstrual pain may return for a day exactly midway between two periods.

(5) Lastly, light may be thrown on the nature of the pain by the conditions which set it up, or which cause relief or aggravation. Is it affected by position? Pains of an inflammatory nature, or due to malposition, are relieved by rest and aggravated by the erect posture. Neuralgic pains are not so influenced. The weary backache, induced by exercise or fatigue, and relieved by rest, is often due to the accumulated effect of the menstrual pain. Again, pain occurring when one position is assumed for a time, but relieved by a change of position, or by walking about, would point to blood stasis—being due to temporary distention of the vessels of the part. A pain which is absent while walking but comes on while sitting is often of this nature.

Is the pain affected by movement? An inflammatory condition is always so. If slight it may be elicited only by a jolt or sudden movement. Neuralgic pains are not so influenced. If muscular, it may only arise on movement of certain muscles. It must be remembered that muscular action produces pressure, and may elicit a neighboring inflammatory pain, as in the action of the psoas muscle in the various positions of the leg.

The pain may be associated with the act of micturition or defecation. In pelvic peritonitis acute pain on micturition is frequent, but there is other pain as well. If closely limited in its relation, occurring with the act and lasting for some time after, the cause is most likely to be in the bladder or urethra (painful caruncle). Intermitting pains of short duration simulating the pains of labor, are met with where something is being expelled from the uterus—such as a blood clot, retained mucous secretion, or dysmenorrhœal membrane. A sharp cutting pain felt at the anus with the act of defecation, and lasting for some time after—simulating every character of fissure in ano, but where no disease of the part can be detected—has been found to be associated with a tender condition of the ovary.

The Constitutional, or Remote Derangements due to Pelvic Affections.—From the endless variety of these it is evident that only a few can be here enumerated, such as every student should be aware of.

1. The digestive system. Want of appetite, sickness, and nausea are frequent. A uterine origin would be indicated if the sickness occurs on assuming the erect posture in the morning, or with exacerbations at the menstrual period, or if the general symptoms show remissions with the pelvic symptoms. Constipation is more frequently a cause or source of aggravation of pelvic disorder than the effect, except where pain on defecation incites the patient to restrain the action. The same may be said of sluggishness of the liver, associated with high-colored or sedimentary urine.

2. The nervous and vascular systems. A pain limited to a spot under the breast is a frequent complaint; also pains in the back, in the lumbar region, or even extending between the shoulders—the parts may be sensitive to the touch. Tic may likewise have a uterine origin, but in such cases it will frequently have a clear association with the catamenial period; it occurs also with pregnancy. The headaches are not always definite in character, they may be frontal, or occipital, or at the vertex. At the change of life the occiput is the more general seat. (See "Change of Life," p. 516.) Through the nervous system, the heart and bloodvessels are frequently affected (palpitation, flushings, and the like). A very common effect, due to pelvic derangement, is coldness of the extremities, which again reacts in aggravating the pelvic pains. Epileptic attacks may occur regularly with the menstrual periods. Spinal irritation has sometimes a uterine origin, as also hysteria and other mental derangements.

3. As a very special influence due to pelvic origin must be noted the faintness and constant feeling of exhaustion, or loss of energy, experienced by many suffering from even slight uterine ailments. In some patients the influence exerted through the pelvic nerves is very marked. Many patients are exhausted and feel faint after each time the bowels are moved. An injection will sometimes cause great prostration. In the same manner inflammation of the cervix and lacerations, the result of delivery, will frequently produce great lassitude and ready fatigue. Hemorrhoids at times have a similar effect. Retroversion of the uterus acts in a similar manner, even when there is no local tenderness. The patient's expression frequently is that all energy or strength seems to go

as soon as she gets up and begins to move about. Tonics are useless in such cases, so long as the local condition is unalleviated. The special pelvic symptoms may be very slight, at other times they are severe and well marked. The grouping of symptoms in such cases generally is follows: Some pelvic suffering, gradually loss of strength and appetite, ready exhaustion, with sickness on assuming the erect position, and steady loss of flesh from inability to take nourishment.

The Determination of the Relation between Pelvic Derangements and Remote or Constitutional Suffering.—Affections of the pelvic organs are known to produce marked disturbances in the function of remote organs; and again, derangements of other parts frequently produce changes in the uterine function. It is, therefore, highly important to decide the relationship. In many cases it is evident enough. Thus, amenorrhœa in a phthisical patient may be regarded as a common effect, not the cause, of the general disorder. When not so clear, the order and succession of the symptoms must be carefully investigated.

When derangements of the stomach are of pelvic origin, there are some special characters which may indicate the association—as when they partake of the characters met with in pregnancy—as sickness, if chiefly on assuming the erect position in the morning; or if manifesting recurrence or exacerbations at menstrual periods; or if coming and going with special pelvic symptoms. The same holds good with many neuralgic affections. Frequently, however, it may be found that whilst due to pelvic irritation the derangement has become permanent and persists, whilst the exciting cause is intermittent, or may even have passed off altogether. The "weary backache" is often of this nature due to menstrual irritation, yet persistent. The early history, however, will reveal the true nature.

The Diagnosis of Pregnancy.

Pregnancy, it must be remembered, may occur under circumstances where it might not be expected, as in very young girls, or in women past the ordinary age of childbearing. Pregnancy has been recorded in this country at the thirteenth year, and as late as the fifty-fourth. Women who have stopped having children for many years may again begin to bear when nearing the change of life; or a woman may be pregnant for the first time after many years of married life. It is very common for mothers who are nursing to be again pregnant without menstruating, or without even being aware of their condition. Again, a patient may have had amenorrhœa for many months, or may always have been very irregular, and yet become pregnant. Caution, therefore, is ever needful, and more especially when the use of the uterine sound as a means of diagnosis is contemplated.

In the latter half of pregnancy, when the uterine tumor is perceptible above the pubes, when either the fœtal movements may be felt, or the auscultatory signs can be heard, and when, in first pregnancies, the mammary signs are distinct, there can be little difficulty in the diagnosis; errors then arise from careless examination. The suppression of menstruation with the occurrence of an abdominal tumor should always necessitate, in the medical practitioner's mind, the exclusion of pregnancy, by the positive evidence of a thorough examination.

In the earlier months the diagnosis is more difficult, and in doubtful cases it should be deferred. The suspicion, though felt, should only be expressed on positive evidence. The sudden arrest of menstruation, without apparent cause, in a woman who has always been previously regular—associated with morning sickness, and shooting pains or fulness in the breasts—is often quite sufficient *presumptive* evidence of pregnancy.

Suppression of the catamenia, although one of the first symptoms, is equivocal in value. It merely opens up the question. The suppression may be due to other causes. It is possible also for a woman to menstruate once or perhaps twice after conception; but in such cases the amount of discharge is markedly diminished. A discharge of blood may also occur during pregnancy, and be repeated at intervals, without being menstrual in its nature.

Morning Sickness alone is of little value; it is variable in its occurrence as to time and duration, is often absent, and may arise from other conditions.

Changes in the Mammæ.—The breasts early sympathize with the condition of the uterus, but they do so in other conditions as well as in pregnancy. They increase in size, and become sensitive with shooting pains. It is in first pregnancies that the areolar signs are of most value, but even then they vary greatly in different individuals; and a deepening of the color, with slight prominence of the nipple, may arise from other conditions of the generative organs. It is in the third month that the increased turgescence begins to alter the characters. The nipple becomes more prominent, the areola increases in size, and its color deepens, whilst the follicles on its surface become more prominent. As pregnancy advances these changes are more pronounced, and the surface assumes a moistened appearance. After the fifth month there may appear what has been described by Montgomery as the "secondary areola," immediately around the other, faint in degree, as if the color had been washed out.

The Abdominal Tumor.—The abdomen is often perceptibly enlarged before the uterine tumor can be felt externally, and before the uterus rises above the os pubis. After the twelfth week, sometimes earlier, the uterus can be defined above this bone; by the sixteenth it should reach midway between the symphysis pubis and the umbilicus; and by the twentieth it is as high as the latter point. It is not always central in position, most frequently there is an inclination to the right. Its uniform spheroidal shape, and moderately firm elastic resistance, are of service in distinguishing between it and other tumors, differing in these respects from the hard uterine fibroid, or the more fluctuating ovarian cyst. Should the consistence change under manipulation, the tumor becoming firmer, it is almost certain to be uterine, though not necessarily due to pregnancy. At times the uterus may be so lax before the seventh month that there may be some difficulty in defining the tumor, especially if the abdomen be full or tense. Mistakes are frequently made from this cause.

Vaginal Examination.—Displacements of the cervix in the earlier months are described in books, but they are unimportant and not reliable. The cervix from an early period undergoes softening of its tissues, beginning in the mucous coat, and gradually invading all the tissues, till toward the end of pregnancy the cervix seems shortened. The vaginal portion is really shorter, from the uterus being held high up, but the cervical canal is not diminished in length till a few days before parturition. In pluriparæ the os in the later months is sufficiently patent to admit the point of the finger. The vaginal mucous membrane early assumes a deep violet hue. The uniform character of the uterine tumor and its consistence, will generally distinguish pregnancy from other causes of enlargement, but of special value is the peculiar soft globular feeling apparent all round the cervix; imparted by the lower part of the body of the uterus. By the bimanual method, an enlargement of the uterus can be readily recognized, and this supplies an important diagnostic sign in the earlier months.

Fœtal Movements.—By the mother these are usually felt, for the first time, from the sixteenth to the eighteenth week; this is spoken of as "quickening." Somewhat later they may be felt by the examining hand, and about the same time *ballottement* may also be made out; this name is applied to the sensation experienced by the examiner, of the resistant body of the fœtus floating in a fluid; this may be made to recede by a sudden push imparted to it by the finger of the observer introduced into the vagina, and applied to the anterior part of the cervix uteri; in a short time it is felt to settle down where it was before. Women who are not pregnant, but have a strong desire to have children, or are suffering from mental ailments, frequently imagine that they feel the movements of a child.

Auscultatory Signs.—The uterine souffle may be heard earlier than the fœtal heart's sounds, but it is not certainly diagnostic of pregnancy; it is, of course, synchronous with the mother's pulse, but a similar sound is heard at times in fibroid tumors. The usual time for the pulsations of the fœtal heart to be heard is the eighteenth week, but they have been detected earlier. In listening for them before the seventh month, a point in the mesial line somewhere between the pubes and umbilicus, but nearer the former, is where the sounds are most likely to be heard. After the seventh month they will be found most frequently about the middle of a line drawn from the umbilicus to the superior spine of the ilium on the right side or the left; but the place must necessarily vary with the position of the child. The rate varies from 130 to 160, and the beats are of course not synchronous with the maternal pulse.

Pelvic Examination.

A systematic examination should always begin by *palpation of the abdomen.* The patient should lie on her back with the thighs drawn up. She should be directed to avoid holding in her breath, and to try to keep the belly lax. Involuntary contractions may at times be overcome by making her talk, but in the finer degrees of palpation, the sudden and frequent changes in the abdomen thus produced will be found to interfere with the delicacy of the touch. The whole hand should be placed flat on the abdomen, and gentle intermitting pressure exercised by the tactile ends of the fingers. The degree of pressure is gradually increased until the deeper structures are reached. Passing the hand over the abdomen, each part in succession is examined. At times it is advisable to employ both hands simultaneously. The size, shape, and consistence of the belly generally are thus recognized. Any tenderness is elicited, and its site and degree are noted. The presence of tumors, hardness or fulness, in relation to the pelvis are also detected. Their exact position, mobility, or fixity, their form and consistence, whether solid, elastic, or fluctuating, are determined. Percussion also is not to be neglected, and in the case of tumors auscultation may be necessary.

Vaginal Examination.—Position of the patient. Three positions are employed in gynecology. Each has its advantages and disadvantages. (1) The side or ordinary obstetric position. This is the one most generally preferred in this country, being more delicate and comfortable for the patient. It affords a fuller range to the examining hand internally than the second position, and does not produce the disturbance of the parts which occurs in the third. It is, however, badly adapted for bimanual examination.

(2) The back position. Whilst the patient lies on her back with the thighs drawn up, the examining hand is placed under the right thigh. This is the proper position for the bimanual examination; but it does not afford the same facility as the first for thorough exploration of the posterior cul-de-sac of the vagina, unless the pelvis be raised and the thighs drawn up to a greater degree than is comfortable to the patient.

(3) The semi-prone position. Here the anterior part of the left shoulder rests on the bed, with the left arm drawn behind the body; the left leg is drawn slightly up, and the right fully flexed; the body is then turned prone till the right knee rests on the bed. The effect of this position is that the influence of gravity is reversed in the pelvis, the weight of the organs is directed into the abdomen. There is thereby produced a marked suction power, whereby, on the introduction of the finger, air is drawn into the vagina, distending it to its fullest capacity. The relations of the different parts are in this way disturbed, so that this position is not a suitable one in which to begin the examination. It is specially adapted for surgical operations, and is necessary when using the duck-bill speculum. It is also a favorable position when rectifying a retroverted uterus, or when endeavoring to raise a tumor out of the pelvis.

It will thus be seen that the side position is to be preferred at the beginning of an examination, but to employ the bimanual method, the patient should be asked to turn upon her back.

Digital Examination.—One finger only should first be used; if the parts are sufficiently lax, there is often an advantage in thereafter using two fingers. The finger, well lubricated, is passed from the perineum forwards between the labia; the orifice of the vagina can then be readily felt, and the finger passed within. In so doing, observation is made of any degree of resistance, the presence of any abnormal swelling or tumor, any undue sensitiveness, tenderness, or sharp pain. The movement should be made slowly and gently; and the importance of recognizing any tenderness in the vulva or orifice of the vagina, lies in the fact that the pain so elicited, if unobserved at first, may be erroneously attributed to parts higher up. Having entered the vagina, the finger is passed along the posterior wall of the vagina, until the cervix is found. Its position and direction are first to be regarded, and the presence or absence of any abnormal condition in its neighborhood. The normal and abnormal conditions will presently be described.

Before completing the examination, it is always advisable to employ the *bimanual method*. With a finger of the one hand in the vagina, the other hand is placed on the abdomen, and pressure exerted in the direction of the axis of the inlet. The internal finger may first be placed in the anterior cul-de-sac, and if the uterus is lying forward it can readily be brought between the hands. If lying backward, nothing will be felt between the hands but the abdominal and vaginal walls. The internal finger may likewise be placed on the cervix or behind it, and the uterus raised or drawn towards the outer hand. The size of the uterus, its position, and the presence and relations of tumors or swellings, can in this way be determined with great accuracy. It is, however, only occasionally, and after some experience, that the normal ovaries can be thus defined. (See p. 532.)

Rectal exploration is at times necessary, and has its advantages. It may be adopted in virgins when a vaginal examination is not advisable. It permits of the finger reaching further back than by the vagina, and in the case of tumors gives further knowledge as to size and relation.

Sound and Speculum.—Having completed the examination by the hands, it is necessary in some cases to obtain further information by means of the *uterine sound* and the *vaginal speculum*.[1]

Mode of Using the Sound.—Before using this instrument the possibility of the patient's being pregnant must be negatived; and it should not be employed by the inexperienced when inflammation of the uterus or surrounding tissue is present. The introduction of the instrument must be guided by the information previously obtained by manual examination. The direction given to the point will be forwards and backwards, according as the uterus is believed to be inclined in a corresponding direction. If a marked flexion has been felt it may be necessary to increase the curve at the distal end of the sound. The instrument should be held lightly by the forefinger and thumb of one hand, and its point guided to the os by the forefinger of the other. As it enters the cervix, when the uterus is in normal position, or anteverted, the stem will be near the under surface of the symphysis pubis. The point must be given a forward direction, and this is accomplished by drawing the handle backwards towards the perineum. When fully introduced, it should rest on that structure. In retroversion, the mode of proceeding is reversed. The distance the point has entered is recognized by the finger in the vagina. The knot or swelling on the stem, represents two and a half inches—the normal length of the uterus—the grooves mark further lengths of an inch. No force must be used, the instrument should glide in by the manipulation of the handle. If resistance be felt, the instrument must be withdrawn slightly, or the point moved about by rotating the stem on its long axis, care being taken that the stem is not made to rotate on its point caught in a fold of mucous membrane.

Diagnostic Uses of the Uterine Sound.—1. *Constriction of the cervix* may be recognized if the lumen be too small to permit the probe to pass (very rare); the narrowing from flexion is recognized by the seat of arrest, and by the special manœuvre necessary to overcome it, such as tilting the sound in a certain direction, or having to press the fundus upwards.

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[1] It is at times further required to explore the interior of the uterus by dilating the cervix by means of tents. This, however, never comes under the charge of the student, and is, therefore, not here entered upon.

2. *The Length of the Cavity.*—The normal length is two and a half inches. It will be found *elongated* in (*a*) recent delivery: the normal size is not reached till the third or fourth week. In repeated examinations a steadily diminishing length of the cavity is valuable evidence of recent parturition. Under various conditions, the diminution in the size of the uterus is arrested (*subinvolution*), both after delivery at the full time and after abortions. Usually, in this condition, it will be found three and a half inches, but may be considerably beyond this. (*b*) In hypertrophy from chronic congestion, metritis, and malignant disease of the body, it may measure three and a half inches. (*c*) From uterine tumors. The amount of elongation is greatly dependent upon their seat; if subperitoneal, the increase may be slight; as they approach the mucous surface the tendency is to lengthen the cavity. A tumor of the fundus may give an apparent shortening. (*d*) The elongation may exist in the cervix only; in the vaginal portion this may arise from hypertrophic elongation of both lips. It may thus measure four to five inches, and has been found as much as nine inches. The portion above the vagina may also be elongated from dragging of the uterus upwards by tumors. (*e*) The cavity is *shortened*, from defective development (infantile uterus); in partial inversion of the uterus; from adhesions, in tumors; in the atrophic state in the aged; in hyper-involution, where the normal process has been in excess.

3. *Displacements of the Uterus.*—These are readily determined by the direction in which the sound passes.

4. *To Ascertain the Connection or Non-connection of Tumors with the Uterus.*—If the sound passes directly into the tumor it proves it to be uterine. A large sub-involuted uterus may thus be distinguished from other swellings. A swelling behind the cervix may thus be determined to be the fundus, or something occupying Douglas's pouch. If the sound does not pass directly into the tumor it may still be uterine, or have uterine attachments. The point is to be decided by whether the moving of the tumor conveys motion to the sound or *vice versa.* The non-uterine nature will be further confirmed if, by aid of the sound, the uterus and tumor can be partially separated from each other.

5. *The sound is further of service, in elevating the fundus or drawing it forward,* so as to bring it within reach of the combined internal and external manipulation, to determine more accurately the size of the organ.

6 *In the Diagnosis of Inversion of the Uterus from a Polypus Projecting through the Cervix.*—In both cases a rounded tumor is felt protruding from the os. In inversion the sound cannot be passed upwards, as the cavity of the uterus is inverted and obliterated, whereas if the case is one of polypus the sound will pass by its side into the uterine cavity.

The Speculum.—Ferguson's tubular glass speculum is the best adapted for general use. Of the bivalve form, that known as Cusco's is now mostly preferred. A good window light is the best, and it should be on a level with the bed. Where the light is bad the tubular form of instrument has a decided superiority in illuminating power.

Should artificial light be necessary, a shade should be devised to screen the observer's eyes.

The lateral position of the patient should, if possible, be adopted. It is less trying to her, and sufficient in the majority of cases. At times, however, with Ferguson's speculum, we may fail to gain a view of the os in the lateral position, when we may succeed in the dorsal. The shoulders of the patient must not be on a higher level than the buttocks. The dress should be carefully adjusted so as not to expose any part of the thighs.

Having oiled the instrument, and holding it in the right hand, we gently separate the labia with the fingers of the left. With them for a guide, the instrument is presented at the orifice of the vagina; we then press it backwards so as to depress the perineum, and with a slight rotary action introduce it within the orifice. The direction is now to be changed backwards, to make it glide over the perineum, not upwards towards the uterus. When once fully introduced, the outward end should be depressed well on the perineum, and if the cervix does not present properly at the inner orifice its position may be altered by a gentle rotary movement of the speculum.

When the bivalve speculum is used, care must be taken that it is introduced fairly behind the cervix before the blades are expanded. The opening up of the blades must be done slowly and carefully, watching the effect meanwhile.

The above forms are those in general use, and are serviceable for inspection, or when topical applications to the uterus have to be made. When any surgical procedure is necessary, the duckbill, or Sims's speculum, has decided advantages. It necessitates an assistant to hold it, but this drawback has been overcome by various modifications. In using it the position of the patient is of great importance. The semi-prone position is necessary, so as to permit of the full distention of the vagina by air.

Pelvic Diagnosis.

1. *Normal Position and Relations.*—To the examining finger the vagina should feel soft, moist, elastic, and roomy, without any fulness or hardness on one side as compared with the other. The cervix uteri is readily reached and the os felt, lying at the end of the examining finger, when fully introduced. The direction of the cervix is downwards and backwards, looking to the coccyx. Through the superior vaginal wall the body of the uterus can frequently be felt freely mobile, and by the bimanual method it can then be readily brought between the two hands. But often it has a backward direction and then the anterior cul-de-sac is felt empty. To the examining finger the cervix should feel freely mobile, and no fulness or hardness should be felt at either side. By pressing upward, the supravaginal portion of the cervix can be defined, and a curve felt when there is any degree of flexion where it joins the body of the uterus. Pressing back the perineum the

finger should feel everything soft and elastic behind the uterus in the posterior fornix. The rectum, however, may contain feces, but these can be readily detected by the peculiar consistence and by the sense of pitting on pressure.

2. *Displacements of the Uterus.*—There can be no true displacement without a change in the relative position and direction of the cervix. But the position and direction of the cervix alone give no certainty as to the position of the fundus, as the uterus is often flexed upon itself. The bimanual method and use of the sound are often required to confirm or correct the impressions derived from digital examination.

(*a*) *Anteversion* is frequently a normal or congenital condition. The cervix looks more backward, the finger defines the supravaginal portion running forward, and the body can be felt freely movable through the superior wall. It can readily be brought between the two hands, and the size, form, and mobility decide it to be the uterus.

(*b*) *Anteflexion.*—The cervix, owing to the flexion, may be in its normal situation, or may even look forward. The curve in the upper portion of the cervix and the body in front can be readily felt. A small fibroid growth in the anterior wall may give the same signs, but by the bimanual examination, aided, if necessary, by the sound, the fundus, and the irregularity in the anterior wall, can be defined. Inflammation of the cellular tissue in front of the uterus may also simulate anteflexion, but by the method just referred to, and by attention to any tenderness and impairment of mobility, a correct diagnosis should not be difficult.

(*c*) *Retroversion.*—Here the cervix is displaced forward and looks down the vagina, or it may be directed upward. The supravaginal portion is felt through the posterior fornix running backward with no angle of flexion. In extreme cases the body can be felt. Bimanually nothing is felt in front.

(*d*) *Retroflexion and Retroversion.*—The cervix is displaced forward and lies in the axis of the vagina. Nothing is felt in front, but posteriorly a firm rounded body can be defined occupying Douglas's pouch. Usually the curve of flexion can be made out. These signs may be simulated by a myoma in the posterior wall of the uterus; and by inflammatory deposits, or blood, in Douglas's pouch. (See also p. 527 and pp. 533–536.) The true condition may be decided by the bimanual method of examination and by the sound, but the diagnosis in these latter cases does not rest on physical signs alone, the history must be associated therewith.

(*e*) *Prolapsus of Uterus and Vagina.*—In the minor degrees of prolapse of the uterus, the conditions are those of retroversion, with increased mobility, or relaxed state of the vagina. In severer forms, and when complete, it is associated with prolapse of the anterior (cystocele) or posterior walls (rectocele). The bulging outward of the walls and the relative position of the cervix readily indicate the condition of the parts. When not wholly protruding, or after replacement, by asking the patient to bear down forcibly the mode of prolapse may be traced by the finger or watched by the eye.

Care in determining the exact position of the cervix and the os uteri will prevent mistakes being made as to the exact relations of the structures. A tumor may, however, protrude from the vagina with the os uteri in its centre, from hypertrophic elongation of the cervix; but here the finger will pass readily into the vagina all round the tumor, and the sound will be found to pass considerably beyond the normal length. The absence of the os uteri and the history will readily differentiate an inversion of the uterus or other tumor.

The uterus may be displaced forward so as to lie behind the symphysis, or backward into the hollow of the sacrum, or more or less to one side, but these changes are always associated with well-marked swellings or tumors, the cause of the displacement. Inflammatory adhesions may also draw the uterus out of place without the presence of swellings; it will then be towards the side where the mischief lies; in the other cases it is to the opposite side.

Cervix Uteri.—In examining the condition of the vaginal portion of the cervix, its size, form, and consistence, together with the degree of patency of the os, have to be observed. It is found smaller than normal in "infantile" uterus, and in the atrophy of advanced years. It may, on the other hand, be longer, in "conical cervix," and when hypertrophied. There is a congenital peculiarity, with a small anterior and large posterior lip, giving the appearance of a curve in the lower portion of the cervix. The os uteri in nulliparæ is small, circular or ovoid, in those who have borne children it is transverse, often fissured generally more on one side than the other, and slightly patent. The rare conditions of occlusion or stenosis can be readily made out by means of the speculum and sound.

The cervix should feel uniformly smooth and of equal consistence, likened to the sensation on touching the point of the nose. In pregnancy it is softened. In diseased conditions the parts (mostly around the os) will feel soft and velvety, or hard, indurated, swollen, or nodulated. Small pea-like bodies may be felt around the os, due to distended Nabothian follicles, and small mucous polypi may also be found projecting from the os.

The speculum is often required to ascertain the exact state of the cervix, and to determine the origin of a vaginal discharge. It should not be used in cases of well-marked cancer of the cervix, and the practised "tactus" soon admits of its being dispensed with in a number of other states for diagnostic purposes merely. The conditions of the parts thus revealed vary greatly, but are chiefly associated with chronic cervical catarrh. In nulliparæ the cervix may appear normal, but issuing from it may be seen a clear, glairy, very tenacious, or it may be a muco-purulent fluid. Frequently, however, the os is surrounded by a red vascular ring, or small angry patches. In multiparæ the os is more patent, the edges are everted, revealing the red inflamed mucous membrane of the canal (the old idea of ulceration). If lacerations exist the ectropion is proportionately increased, and when extensive may present a widely gaping angry surface. At times the inflamed area presents a *granular* appearance, and when the subjacent glands are obstructed small prominent cysts form, scattered about the os ("follicular erosion"). The surface may also be covered by abundant granulations, with the cervix swollen and enlarged from parenchymatous inflammation. When the ectropion is extensive and due to severe laceration, the condition may be recognized by means of tenacula inserted into both lips, drawing these in upon one another the raw looking surface will generally disappear and the natural form of the cervix be restored; there may still, however, be some angry points on the vaginal surface proper. True chancres, condylomata, and syphilitic ulceration are to be met with on the cervix, but they are rare. The history will materially aid in the diagnosis.

Malignant Diseases of the Cervix.—*Epithelioma* occurs in two forms, a superficial ulceration excavating the cervix, with little or no tendency to papillary sprouting; and a papilloma sprouting from the vaginal portion, and extending or projecting into the vagina, but with little or no tendency to involve its walls (cauliflower excrescence). These forms produce at first very little hardening of the adjacent tissue, but infiltration does occur to some extent where the disease is far advanced. *Medullary carcinoma* is the more frequent form.

The vaginal portion of the cervix becomes either uniformly indurated and tumefied or several hard nodules are formed. The tendency is to rapid infiltration of the surrounding tissues, with ulceration and destruction of the parts forming the canal. It is consequently seldom seen until these changes have occurred. The cervix then presents to the finger a ring or cup of dense indurated tissue filled with softened pulpy tissue undergoing sloughing or ulcerative changes. The uterus is at this stage fixed. The infiltration may be felt extending into the broad ligaments, or the induration may have extended along the vaginal wall, involving the bladder or rectum, or both. At times the vagina may be so blocked up that the finger can be passed only a short way.

These characters are too pronounced to be readily mistaken, but in the earlier stage of these diseases the diagnosis is often very uncertain even to men of experience. When doubt is felt a small portion of the tissue may be removed for microscopic examination. A condition which is liable to be mistaken for malignant disease is where the cervix is enlarged and indurated from chronic inflammation. The diagnosis is rendered more difficult when the os is patent, and ulcerations or granulations are present. Many means have been suggested to determine between the benign and malignant forms of disease, but the microscope is the only reliable one.

The Ovary.—With the forefinger of the one hand in the vagina or rectum, and pressing well down with the other from above, it is just possible to define clearly the ovary. But in many cases where the woman is healthy and in good condition, with a moderate degree of fat in the abdominal wall and padding the pelvis, one is as likely to fail, especially when the ovary is normal. When, however, the organ is diseased, enlarged, or firmer than normal, and when displaced, it can generally be felt. Any adhesion or thickening of the parts around it obscures the examination; the isolated mobile roundness of the organ is lost in diffused or irregular hardness. The usual situation is to the side of the vagina and posterior to the cervix; at times, but rarely, it is in front. Often it will be found prolapsed, lying in the pouch of Douglas. The size, consistence, and degree of tenderness must be noted. The healthy ovary is sensitive to pressure; when diseased it is often acutely tender, the pain being associated with a peculiar sickening feeling. From inflammation the ovary may attain the size of a large walnut or small hen's egg; when larger it is due to the formation of cysts; the organ may then feel distinctly elastic. Ovarian cysts, which occupy the pelvis but do not extend into the abdomen, have to be differentiated from cysts of the broad ligament, dilatation of the Fallopian tubes, pelvic abscess, pregnancy and extrauterine pregnancy, pelvic hæmatocele, intestinal prolapse in Douglas's pouch, retroflexed uterus. For the special diagnosis the systematic works must be consulted.

Affections of the Vulva and Orifice of the Vagina.—These parts are liable to many affections, common to the body generally, such as eruptions of the skin, simple, erysipelatous, and syphilitic inflammation, abscesses, cysts, congenital malformations, etc., for an account of which the systematic works must be consulted. Here those only can be referred to which are likely to complicate a vaginal examination, or are required to elucidate some special symptom. 1. *Increasing sensitiveness or pain* on making an examination, may arise from inflammation of the vulva, vaginitis, fissure of the vaginal orifice, small, highly vascular and sensitive points in the mucous membrane, or a similar general condition around the orifice. These conditions are associated with a strongly spasmodic condition of the sphincter vaginæ, and constitute what has been termed " vaginismus. The sensitiveness may also arise from a painful caruncle at the orifice of the urethra, or from hemorrhoids. 2. *Swelling or tumors of the labia.* We may have abscess, varicocele, thrombi, inflammation of the gland of Duverney or occlusion of its duct, dermoid cysts, hernia through the canal of Nuck (bowel, omentum, or ovary), and hypertrophy. 3. *Pruritis.* This is a common accompaniment of many special affections, such as various eruptions, and discharges; but it often occurs without any visible change in the parts. It may arise from local or constitutional causes; amongst these are pregnancy, the menstrual period, rheumatic or gouty tendencies, diabetes, oxaluria, cystitis or urinary calculi, cancer of the uterus, pediculi, scabies, and oxyurides. It is met with at all ages, and is frequent from senile changes.

Perimetritis and Parametritis.—Two forms of pelvic inflammation are met with—perimetritis or pelvic peritonitis, and parametritis or inflammation of the cellular tissue around the uterus. Although they are pathologically distinct, and do occur separately, yet practically they are often combined, and attempts to lay down signs for their differentiation have as yet signally failed; the best authorities are by no means agreed. Amongst the differences tabulated in several books there is no one point to which exception may not be taken.

The earliest sign is *fulness* on one side as compared with the other, or posteriorly, the feeling of resistance at the part is increased, and in most cases there will be tenderness on pressure. The feeling of resistance further increases and passes into *diminished mobility, hardness or induration, and fixation.* The hardness may be diffused, like a phlegmon, or more defined, giving the sensation of a tumor. The situation of the hardness or tumor varies. The whole roof of the pelvis may be rendered firm or resisting, the uterus lying embedded in the inflammatory products. More frequently the swelling is limited to one side of the pelvis, displacing the uterus to the other. The lateral swelling may be extensive, lining the pelvic wall, or limited to the base of the broad ligament. In the latter case the fulness and hardness will be felt immediately to one side of the uterus and above the level of the vagina. Very often the inflammatory products are immediately behind the uterus, lying in the pouch of Douglas, displacing the uterus forward, and at times partially encircling the cervix. In these cases the swelling does not pass in front of the cervix, but at times the cellular tissue between the uterus and bladder is inflamed by itself; this, however, much rarer than the other situations. The tissues in the immediate neighborhood of either ovary may be separately involved The swelling will then be in the posterior lateral quarter of the pelvis. At times the hardness may not be reached by the finger in the vagina but may be recognizable from above or detected only by the combined method. Although generally extensive and readily recognized, yet it must be remembered that the inflammation may also be very limited in extent and not always associated with hardness; a slight fulness, limited in area, but very tender to pressure, may be the only sign.

When the finger receives the sensation of hardness and fixation, the mind naturally attaches thereto the idea of thickness, and if the area be considerable, with marked signs, the interpretation is a solid tumor. This impression is further confirmed if a similar sensation is imparted to the hand above. Nevertheless no solid tumor may exist. An inflamed and adherent peritoneum, such as Douglas's pouch, may feel like a hard lump, and the matting together of the broad ligament and intestines, may impart all the sensation of a solid tumor. Pelvic inflammatory tumors of large extent are always of this nature, "the apparent volume is in accordance with the extent of these adhesions."

The phlegmon may extend from the pelvis into the iliac fossa; or forward and upward on the abdominal wall above Poupart's ligament, and rising upward as high even as the umbilicus. In other cases the inflammation extends along the psoas muscles and may reach as high as the kidney, or it may have a separate origin in this region. From the pelvis the inflammation may likewise pass to the inner side and front of the thigh.

The differential diagnosis of inflammatory tumors from others which may be confounded with them often rests on other points than physical signs, and especially on the history. These cannot be dealt with at length here. Among the more frequent of these other conditions are—1. *Pelvic Hæmatocele.* The diagnosis is often difficult, and will rest chiefly on the mode of onset, its association with signs of loss of blood, and the course of disease. 2. *Retroflexed and retroverted uterus,* pregnant or non-pregnant. There is not the same degree of hardness, and there is not in general the immobility found in inflammation, but a retroverted uterus may also be involved in a perimetritis. 3. *A prolapsed and enlarged ovary* will be mobile unless it also is associated with perimetritis. 4. *Accumulation and impaction of feces.* The peculiar consistence and pitting on pressure, the frequent absence of pain, and independent mobility of the uterus, should guard against errors. 5. *Fibroid tumors* of the uterus. Their close relation to the uterus and mobility, in many cases, render their recognition easy; but when large they may become impacted, or there may be intercurrent attacks of inflammation; the question then becomes one of great difficulty. Increased length of the cavity of the uterus, recognized by the sound, would point to a uterine fibroid. 6. *Prolapse of the bowel into Douglas's pouch.* There may be a true hernia of the bowel behind the uterus, pushing the organ forward, and forming a well-defined fulness or tumor behind. When not inflamed, it may be recognized by its peculiar elastic resistance, with its repressibility upward and ready return. When inflamed and adherent it presents a hard tumor, the nature of which it may be impossible to determine. 7. Finally, the possibility of *cancer of the peritoneum,* and more rarely *tubercular deposit,* must not be overlooked. Their recognition is dependent upon other conditions than those recognized by the hand.

In conclusion, we would remark that the cultivation of the habit of a careful and thorough exploration of the pelvis is the only sure means of guarding the practitioner against error. We frequently see the attendant contented with the diagnosis of some easily recognized condition, such as retroversion of the uterus, while he overlooks the true cause of the patient's suffering—pelvic peritonitis; or a pelvic cellulitis may remain unrecognized because no hardness is felt per vaginam; still more frequently debility and general symptoms have been attributed to the stomach, or to nursing, or to anæmia, when there was a pelvic origin for all, although this remained unrecognized, because the examination was too cursory, or perhaps never thought of at all.

The following general works may be referred to: Thorburn, Practical Treatise on the Diseases of Women, London, 1885.—Duncan, (J. Matthews), Clinical Lectures on Diseases of Women, third edition, London, 1886.—West, Lectures on Diseases of Women, fourth edition, with additions by Dr. Matthews Duncan, London, 1879.—Barnes, Clinical History of the Medical and Surgical Diseases of Women, second edition, London, 1878.—Graily Hewitt, Pathology, Diagnosis, and Treatment of Diseases of Women, fourth edition, London, 1882.—Simpson (Sir James), "Works," volume 3, containing Lectures on Diseases of Women, Edinburgh, 1872.—Schröder, "Diseases of the Female Sexual Organs," in Ziemssen's Cyclopædia, vol. x., London, 1875.—Thomas (T. Gaillard), Practical Treatise on the Diseases of Women, fifth edition, Philadelphia, 1880.—Emmet, Principles and Practice of Gynecology, third edition, London, 1885.—Courty, Practical Treatise on the Diseases of the Uterus, Ovaries, and Fallopian Tubes, translated by Agnes Maclaren, M.D., London, 1882.

Manuals: Edis, Diseases of Women, second edition, London, 1882.—Galabin, Students' Guide to the Diseases of Women, third edition, London, 1883.—Hart and Barbour, Manual of Gynecology, Edinburgh, 1882.—Atthill, Lectures on Diseases Peculiar to Women, seventh edition, Dublin, 1882.

The elaborate Handbuch der Frauenkrankheiten, 3 vols., Stuttgart, 1877–82, edited by Billroth, may be referred to as a cyclopædic work on this subject.

Of special works, the "Memoirs" of Bernutz and Goupil, translated by the New Sydenham Society, London, 1866–67, may be mentioned in connection with their researches on Pelvi-peritonitis. Sir Spencer Wells, Diagnosis and Surgical Treatment of Abdominal Tumors, London, 1885.—Lawson Tait, Pathology and Treatment of Diseases of the Ovaries, fourth edition, Birmingham, 1883.—Peaslee, Ovarian Tumors, New York, 1873.—Péan, Diagnostic et Traitement des Tumeurs de l'Abdomen et du Bassin, 2 vols., Paris, 1880–85.—Montgomery, The Signs and Symptoms of Pregnancy, second edition, London, 1856.—Skene, Diseases of the Bladder and Urethra in Women, New York, 1878.

CHAPTER XVI.

THE PHYSICAL EXAMINATION OF THE CHEST AND ABDOMEN.

PART I. PHYSICAL EXAMINATION OF THE LUNGS.

REGIONALLY the chest is usually divided as follows: The anterior regions are the *clavicular*, the *supraclavicular*, the *sub-clavicular*, the *mammary*, the *suprasternal* (or the jugular fossa), and the *sternal* (upper, middle, and lower). The lateral regions are the *axillary* and the *infra-axillary*. The posterior regions are the *suprascapular*, the *scapular* (including the supra- and infraspinous spaces), the *interscapular*, and the *infrascapular*. Such words as "vertical," "above," "below," etc., are always to be understood in the anatomical sense, as if the patient were standing erect.

No detailed description of these regions need be given, as the names speak for themselves, and in all cases where great exactitude is required, it is preferable to indicate the point to be noted, not by simply naming or sub-dividing the region in which it lies, but by taking some definite anatomical landmarks, such as a rib, the midsternum, a vertebra, or the clavicle, and giving exact measurements from these points. For this purpose the observer should always be provided with a measure of length, and it is well to have it doubly divided according to English inches and eighth-parts of an inch, and according to the French metric scale which, with decimal subdivisions, is almost universally used on the continent in all medical observations. It is convenient also to have a scale of inches, or of centimetres, marked on the upper surface of the pleximeter, but care should be taken that the markings are accurate from end to end.

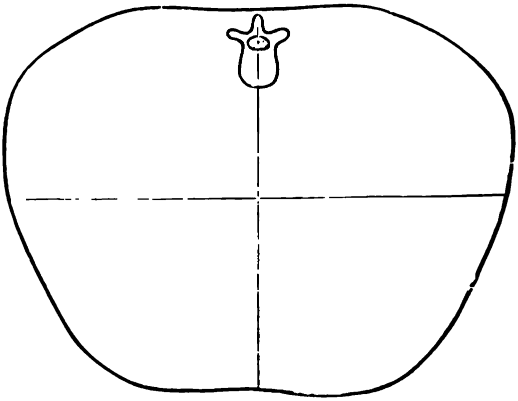
The methods of investigation pursued in the physical examination of the lungs, are inspection, palpation, mensuration, percussion, and auscultation.

INSPECTION.

This should be conducted, if possible, with the thorax quite exposed, but for a variety of reasons it often happens that only a partial view can be obtained. Then, if it is possible, the patient should be placed in the sitting posture to enable the observer to view the chest from all points, and especially from above downward over the shoulders. The light should be good and should fall directly on the chest; the attitude should be erect, yet unconstrained. Too long exposure of the chest is to be avoided, and shawls can be used to lessen the danger of catching cold. The points to which attention is directed in this survey are: (1) The shape of the chest. (2) The movements of its walls.

The Shape of the Chest.—This can be estimated in a general way by the eye; but the circumferential shape is accurately determined by the "cyrtometer," an instrument perfected by Woillez; and by it also the relation which the two halves of the thorax bear to each other can be gauged. A very handy form of cyrtometer can be improvised with two pieces of ordinary composition gas-pipe, united by a piece of India-rubber tubing as a joint. The joint is applied directly over the spinous processes and held firmly in position. The two pieces of pipe are then brought round the sides and moulded accurately to all the inequalities in the chest wall. They are crossed in front, the one above the other, and a mark should

FIG. 96.



Circumference — 89 centimetres.

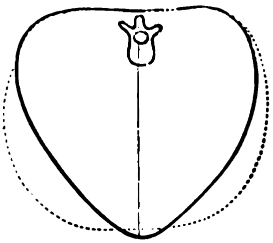
Transverse section of healthy adult chest upon level of sterno-xiphoid articulation. (Dr. Gee.)

be made on them to indicate exactly the mesial line of the sternum. The joint allows them to be removed without destroying the "set;" the apparatus is adjusted on a sheet of paper, and a tracing made with pencil or ink. The measurement is usually made about an inch below the level of the nipple, or at the sterno-xiphoid joint.

In the healthy child the typical chest is somewhat circular, while in the adult it takes the form of an ellipse, the transverse diameter exceeding the antero-posterior.[1] (See Fig. 96.)

The variations from the typical forms are considerable, and are quite consistent, in many cases, with a healthy condition of the thoracic organs—occupation, accident, and various conditions inducing the changes. There are, however, two typical

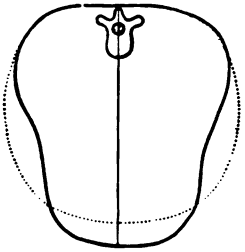
FIG. 97.



Circumference — 57.5 centimetres.

Pigeon-breast. Tracing taken from a child 'of seven years. Dotted line indicates the natural shape at same age. (Dr. Gee.)

FIG. 98.



Circumference — 42.75 centimetres.

Rickety chest. Dotted line indicates the shape of chest in an infant about the same age. (Dr. Gee.)

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[1] The following table, given by Dr. Gee, illustrates the circumference, and the ratio of the diameters to the circumference in healthy chests at different ages. All the measurements are taken on a level with the sterno-xiphoid-joint.

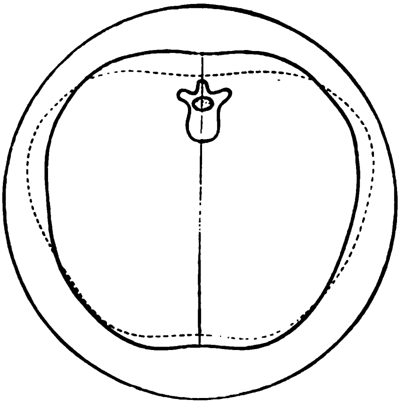
Age.	Actual circumference.	Ratio of diameters to circumference.	
		Antero-posterior.	Transverse.
3 months	14¾ inches (37.5 c.)	26	29
2 years	18 " (45.75 c)	26	32
34 "	29⅗ " (75 c.)	26	35
48 "	35 " (89 c)	27	31

deviations from the normal which are tolerably constant in their characters; the one is the "pigeon-breast," and the other the "rickety chest."

In the *pigeon-breast* (see Fig. 97) the sides are flattened, and the sternum is carried in advance like a keel. It occurs in childhood, when the ribs are yielding and adapt themselves readily to any shape, from diseases in which great strain is thrown upon the lung as in whooping cough, measles, etc., and is especially liable to take place in a rachitic subject.

The deformity that results from *rickets* alone is a contrast to this. (See Fig. 98.) In it a constriction occurs in the lateral region, and there is not the same sharp projection of the sternum, as in the pigeon-breast. The chest, in fact, becomes somewhat quadrilateral. In rickets also there is usually more or less enlargement of the sternal ends of the ribs, giving rise to a series of little nodules or "beads," which may be seen as well as felt, constituting the so-called "rachitic rosary."

FIG. 99.



Bilateral enlargement of emphysema.

Inner line -- emphysematous chest.
Outer line = a circle drawn to show how nearly the emphysematous approaches the circular shape.
Dotted line = natural adult chest.

Actual measurement in centimetres.

Circumference	=	natural	89.	emphysematous	87.75.
Transverse . .	=	"	29.6	"	27.25.
Antero-posterior	=	"	22.25	"	25.4.

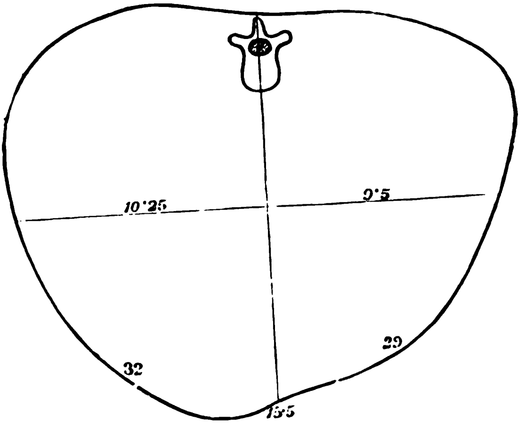
(Dr. Gee.)

These deformities do not necessarily indicate disease of the lungs, but are frequently associated with it.

The two sides of the chest are nearly symmetrical, the left, however, being usually a little less in circumference than the right. This symmetry is often impaired by local conditions which may be quite unimportant.

Emphysematous Chest.—In well-marked emphysema there is a reversion toward the infantile type, in respect of the altered proportion of the antero-posterior to the transverse diameter. (See the Table, p. 540, and Fig. 99.) The chest becomes more cylindrical, or, as it is often called, "barrel-shaped;" the sternum is more arched from above downward than in the normal condition, and the costal cartilages, along with the sternum, present also an excessive arching transversely, so that the front of the bony case seems unnaturally bulged forward, while the lower ribs are laterally compressed. There is, however, this well-marked difference between the emphysematous and most of the infantile deformities, that in proportion as the former take place after the bony and cartilaginous structures have been consolidated, the changes are gradual and devoid of abruptness. We rarely or never find, accordingly, the pigeon-breast, or the depressed and incurvated

FIG. 100.



Unilateral retraction of chest; consequent upon cirrhosis of left lung in a girl of fourteen years. The figures indicate antero-posterior and transverse diameters, and semi-circumferences of right and left half of chest. (Dr. Gee.)

ribs of the rickety infant among the emphysematous deformities of adult age.

Unilateral changes may also occur. There may be *bulging* of one side from effusion of fluid or air into the pleural sac; tumors of the lung, such as cancer, have a similar effect, and even in pneumonia, if it is extensive, there may be a slight but decided increase on the affected side. *Retraction* of one side may occur from cicatricial processes in the lung tissue, as in phthisis or abscess, or from the lung not expanding after the absorption of a pleural effusion of air or fluid. (See Fig. 100.) If the retraction is extreme, lateral curvature of the spine is usually present, the convexity being directed toward the sound lung, and curvatures of the spine from other causes may, in like manner, give rise to distortion of the chest.

The sub-clavicular regions always demand the most careful inspection, as a degree of flattening there often attends the deposition of tubercle.

Local bulgings may occur in the chest wall, in the region of the heart, from pericardial effusion or extreme dilatation or hypertrophy of the organ itself; aneurisms or tumors in any part of the chest may give rise to similar deformities, and an empyema when pointing does the same.

Movements of the Chest Walls.—In estimating these, the student must keep before his mind the fact that in women the thorax moves more freely during respiration than in men; the type being more thoracic in the female and more abdominal in the male. The movements should be observed first in quiet respiration, and then the patient should be directed to take one or two deep breaths, filling the chest slowly and fully. Both inspection and palpation should be brought to bear on the determination of the amount of movement.

The thoracic respiratory movement may be *exaggerated* and this is especially the case when the descent of the diaphragm is impeded, as from pregnancy, and tumors or other conditions in the abdominal cavity. On the other hand, the thoracic movement may be much *restricted*, and abdominal respiration greatly exaggerated, as in cases where the respiratory forces of the chest are at fault (as in paralysis of the muscles), and the whole work of respiration is thrown upon the diaphragm. There may, however, only be a deficiency in the expansion of the thorax as a whole, as in pronounced emphysema; or in the same disease the lower zone may be sucked in by the action of the diaphragm, while the upper half is forcibly raised by the scaleni and sterno-mastoid muscles, without, however, there being a corresponding amount of expansion. In obstruction of the larynx and trachea (as in cases of croup in children) we find certain parts sucked in during the violent efforts at inspiration; in particular, the lower portion of the sternum, the lateral regions of the chest wall above the level of the liver, and the supraclavicular and the suprasternal regions. In children the soft bones yield readily to the atmospheric pressure which exerts this influence owing to the air not entering the lung freely enough to balance it within; the amount of the recession becomes thus a gauge of the severity of the case.

Movement may be in abeyance over *one side* or the other, from extensive pleuritic effusion and pneumothorax; or from retraction arising from non-expansion of the lung after old pleuritic effusion; or from chronic excavation or fibroid shrinking of the lung. Or the restricted movement may only exist at the *base*, the sound side and upper half of the affected one being thrown into undue motion. Pneumonic and other consolidations at the base and modern pleuritic effusion give rise to this. The movements at the apices should be critically observed, and here inspection and palpation are very usefully combined. The observer stands behind the patient with a thumb on either scapular spine, while the tips of his fingers lie over the apices in front immediately beneath the clavicles. The patient is then directed to inspire fully and quietly, and by scrutinizing the complex movements of the ribs and watching the rise and fall of the fingers, a very accurate comparison of the expansion of the two sides can be made. Deficient expansion at either apex is a very important fact as indicating disease of the lung, usually phthisical.

PALPATION.

This has already been referred to as a very important adjunct to inspection in determining the expansion of the upper part of the chest (*vide supra*), and it will naturally occur to the student to employ it in estimating more exactly than by inspection alone, deficient or undue movement in other parts of the thorax. Palpation will also determine the condition of the intercostal spaces, which may be unduly prominent, resistant, and wide, as in cases of effusion into the pleura either of air or fluid, or in the region of the heart from pericardial effusion; or they may be diminished in size by the approximation of the ribs, as in cases of collapse or shrinking of the lung. Fluctuation or elasticity may sometimes be detected in the intercostal spaces in cases of fluid effusion, and in some instances pleuritic friction, the vibrations from snoring râles in the lungs, and the grating sensation present in some forms of emphysema may be realized. Specially tender spots or regions may also be detected during palpation. The condition of the vocal fremitus, the presence of pulsations and thrills (cardiac or aneurismal), and of pleuritic or pericardial friction fremitus may also be noted, but these will be discussed under their respective heads. (See pp. 636, 640, 653, 674.)

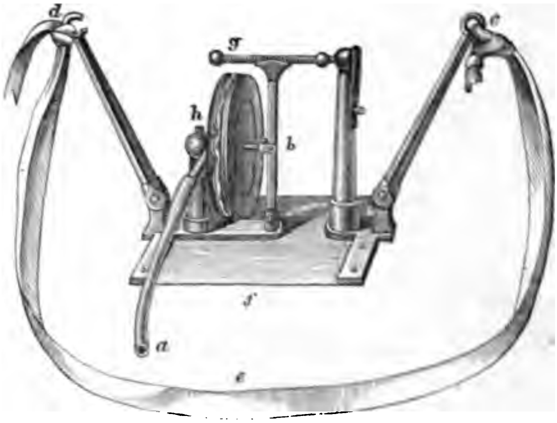
MENSURATION.

If the circumference of the two sides is required, the student should first mark in ink the tips of the spinous processes, some of the vertebræ, and in a like manner the mesial line of the sternum, taking the centre of the jugular notch and of the xiphoid cartilage as guides. The semi-circumference is taken from these lines, the measurements being made at exactly similar levels, the tape applied accurately and with equal tightness to the chest wall, and the two observations made either on inspiration or expiration, or on both. The level most commonly selected for the measurements is about two inches below the nipple in a line with the sterno-xiphoid joint, the advantages of this situation being that it is quite free from bulky muscles and below the scapulæ. A favorite method of measurement is by the double tape, which is simply two tapes joined. Their line of junction is placed exactly over the spinous processes, they are brought round on either side, and the circumference of the two halves can be read off at once and their relative degree of expansion noted.

In the average healthy chest the right side is usually found to exceed the left in circumference by about three-fourths of an inch. But the circumference of either side may be *increased* from morbid conditions, as in cases of effusion of air or fluid into the pleura or pericardium, in unilateral emphysema, or in thoracic tumor. In œdema of the chest wall also, if the patient lies habitually or for any length of time on the one side, the fluid will gravitate so as to increase the circumference on that side. But the circumference may be *diminished* from shrinking of the chest wall in collapse of the lung, after pleural effusion or from retraction in phthisis. Discrepancies may also arise from deformities of the walls or from curvature of the spine. (See shape of chest as gauged by the cyrtometer, Fig. 100.)

The antero-posterior diameter of the chest may be estimated by the cyrtometer or by callipers, one blade being placed in front and the other behind; and the movements of respiration may be accurately determined by the "*chest measurer*" of Dr. Sibson, or the *stethometer* of Dr. Quain, both of which indicate on a dial the degree of expansion. The *spirometer* of Dr. Hutchinson, which measures the quantity of air breathed out, is used to determine the "vital capacity" of the lungs; while the *stethograph* of Ransome gives tracings of the movements of the chest walls. Marey's *pneumograph* is a very handy and simple instrument for recording the movements of the chest walls. (See Figs. 101 and 151; compare pp. 102 and 346.) All these instruments, however, are of much more value in physiological than in clinical investigation. Dr. Ransome's "*chest rule*" may also occasionally be used with advantage to note accurately the area of any percussion-dulness, or the exact position of any pulsation, auscultatory phenomenon, etc., which it may be necessary to record.

FIG. 101.



Pneumograph of Marey. *f*, very thin brass plate bearing a tambour, *h*, the aluminium disk of which is connected with the upright *b*, the upper end of which moves on a horizontal screw, *g*. The band *c e d* is placed round the body. During expansion of the chest, tension occurs between *c* and *d*, which acts on the tambour by the bending of the brass plate *f*, and the movement is communicated to a recording tambour by *a*. (MacKendrick.)

PERCUSSION.

This may be performed without any instrument, the fingers of the one hand acting as the "plessor," and those of the other as the "pleximeter." But the ivory pleximeter of M. Piorry may be used or the various modifications of it, and the stroke may be dealt by Wintrich's hammer. This last is, as a rule, only useful for purposes of demonstration to a large class or to educe sounds which require a strong stroke—*e. g.*, the "cracked-pot sound," or to elicit the note in parts thickly padded with muscle as in the supra-spinous regions in the back. When the pleximeter is used it should be firmly and closely applied to the skin, the percussing stroke should be delivered on its centre, and if the finger is used as the plessor, care should be taken that the nail does not impinge upon the ivory. But the fingers give the most delicate results, and in very critical percussion they are indispensable, as they enable the physician to estimate the degree of resistance to his stroke with greater delicacy than by any other method. The finger playing the part of the pleximeter should be applied firmly and flatly to the chest wall, and the stroke should be as direct and perpendicular as possible, with a well-controlled movement from the wrist and not from the elbow. Care should be taken that no sound is generated by the contact of the nails. Occasionally, "immediate" or direct percussion is employed, the fingers striking the chest wall directly; this is especially useful in the clavicular region, the bone there acting as a kind of pleximeter for the apex of the lung behind it.

In the back of the chest the lower limit of lung-percussion is on a level with the tenth or eleventh dorsal spine. In front on the right side it is bounded inferiorly by the upper border of hepatic dulness—*i. e.*, about an inch and a half below the nipple, while on the left side it is bounded at the lower border of the third rib by the cardiac dulness, and in the left lateral region by the stomach and spleen. In the upper front, the apices of the lungs project to some extent above the clavicles into the supra-clavicular spaces.

The parts of the chest which should be most carefully percussed are the apices both in front and behind, the interscapular regions, the axillary regions, and the bases. Each point on the one side should be carefully compared with a similar point on the other, and in many instances also with different parts on the same side. Every stroke should be made to yield results, and no spot should be lingered over separately and without comparison with others, as the ear is apt to get confused. If dull percussion is detected, especially in the lower part of the chest, it should be tested with the patient in various attitudes, for pleuritic effusion, if free, will be found, in some instances, to obey the law of fluid level, and the area of dulness will vary with the position of the patient. This is especially marked in cases of hydro-pneumothorax. In percussing above the clavicle, care should be taken that the stroke is directed away from the trachea. It is also well to remember that in health the percussion note of the left apex, especially in women, is often a little flatter than the right.[1]

Over the healthy lung the percussion note is termed "*clear*," and the junior student will do well to contrast it carefully with the note obtained over the stomach, which is "*tympanitic*" or drum-like, and that over the liver which is "*dull*." No uniform standard can be set up for the pulmonary note in all cases, as there are so many modifying circumstances. For instance, if the chest walls are well covered with muscle or fat, the pulmonary note may be very obscure, especially in the back; and in such cases it is only by a careful comparison of all parts of the chest that a standard can be arrived at for the individual patient.

The percussion note over the lungs may depart from the normal in the direction either of *hyper-resonance* or of *dulness*. If over one side of the chest a frankly tympanitic note is got, pneumothorax should be suspected, and other signs will generally confirm the diagnosis. But a more localized and much less pronounced tympanitic note may be obtained in many instances at the apex of a lung from tubercular excavation if near the surface; or where there is consolidation of the lower lobe as in pneumonia; or where the lower lobe is compressed by pleural effusion, especially if that effusion is advancing or beginning to recede. In these cases, however, the tympanitic quality is usually associated with some diminution of resonance so that the note is so far dull.[2] In emphysematous conditions of the lungs the mass of the percussion sound is increased or exaggerated, while at the same time it is lowered in pitch.

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[1] The normal pulmonary percussion sound is possessed of the qualities of pitch and intensity, the former depending upon the number of vibrations in a given time, the latter upon the magnitude of these vibrations. It has, however, no distinct musical quality, no "timbre;" it is a sound, not a tone; and so contrasts strongly with the drum-like note educed from the air-filled organs in the abdomen. The pitch of the percussion sound depends chiefly upon the degree of tension of the thoracic parietes, although to some extent also upon the degree of tension of the lung tissue itself. The greater the tension the higher the pitch and *vice versa*.

[2] Skoda was the first to call particular attention to this tympanitic quality of percussion note in cases of pleural effusion, and hence by many French observers it is designated "*bruit skodique*."

Dulness over the lungs may be due to changes in the organs themselves, or in the pleuræ. All forms of pulmonary condensation lead to it, such as pneumonia, tubercular or cancerous disease, œdema, congestion, collapse, etc. The dulness in such cases may affect any part of the lung, but in the great majority of instances the bases are chiefly involved; tubercular consolidation, however, is a marked exception to this, the apices being most frequently affected, the first hints of it being often obtained by a change in the percussion note in the supraclavicular spaces.

Dulness depending on changes in the pleura may result from thick layers of lymph or fluid effusion; in the latter case, if it is moderate and free, the dulness will gravitate to the base, but if the effusion is large the whole side may yield an absolutely dull note, and it may even cross the mesial line, and reach above the clavicle. (See Fig. 106.) The dull note in rare cases may depend on pneumothorax, where the air is present in such quantity as to distend the pleural cavity to its utmost; if a little air is let off in such instances by a hollow needle, a tympanitic note becomes developed. Thickening of the pleura will diminish the pulmonary resonance, and in collapse of the lung with retraction of the side, the resonance will, of course, be seriously impaired if not altogether lost.[1]

But area of dull percussion may occur from other causes than changes in the lungs or pleuræ. Thus aneurisms or dilatations of the aorta, glandular tumors, cancer, pericardial effusion, or dilated or hypertrophied conditions of the heart may encroach on the limits of lung-percussion. These areas should be carefully mapped out, and other signs will usually guide the diagnosis. The displacements of the heart are considered under the head of cardiac diagnosis. (See page 569.)

The cracked-pot sound (Bruit de pot fêlé) demands special mention. It is a modification of the tympanitic, and can be well imitated by striking the hands folded across each other over the knee. The best method to elicit it is by a strong stroke, and this is one of the instances for the use of the percussing hammer. The patient should keep his mouth open and breathe quietly. In the adult this sign generally indicates a cavity in the lungs, but it may be present in healthy children, owing to the yielding nature of the chest walls. Walshe says it is usually got over the chest of a crying infant on expiration. If a patient, who develops this sign, inspires deeply and then holds his breath during the percussion, the cracked-pot sound will disappear. The quality is most marked in expiration, and it is essential for the production of the phenomenon that the cavity shall be in free communication with the bronchus.

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[1] In cases of moderate pleural effusion where the fluid is free, the line of dull percussion is not perfectly horizontal, but more or less curved. Observers are by no means agreed, however, as to the exact shape of the curved line; and as the scope of this work precludes detailed examination of the question, the student is referred to Dr. Garland's monograph upon "pneumo-dynamics," where he will find full details and an excellent bibliography.

AUSCULTATION.

Auscultation of the lungs may be conducted either *mediately* by the stethoscope, or *immediately* by the application of the ear to the chest wall. The former is the method more commonly employed in this country, although in certain instances, especially in the auscultation of children, who are easily frightened by the sight or pressure of the stethoscope, the direct method may be more advantageous. But even in children the stethoscope is often essential for exact observation, and with a little manœuvre the fear of the instrument can usually be overcome. In adults also it is often well to auscultate the back of the chest "immediately," a thin soft towel or handkerchief being interposed between the ear and the skin. In selecting a stethoscope the student should see that it fits his ear accurately. The form of the instrument is not of very much consequence, and it may be made of metal, vulcanite, or wood. The ear-piece should be large enough to cover the whole concha—say from 2½ to 2¾ inches in diameter, and slightly concave to admit of the exact application of the ear. The bell should be large enough to bridge over an intercostal space—from an inch and a sixth to an inch and a quarter in diameter.

The stethoscope should be applied directly to the chest without the intervention of any clothing, and it is necessary that it should be planted quite fairly, so that the whole of the circumference of the bell may be in contact with the skin. Moderate pressure with the head will keep it in position, but care should be taken that undue pressure is not exerted, as it not only causes pain, but may even impede respiration to some extent. Beginners, as a rule, are apt to press far too heavily. Care must be taken to obviate friction between any part of the patient's dress and the stethoscope, or between the patient's dress and his skin in the vicinity of the instrument. In patients who have much hair developed on the chest, the student must be careful that he does not mistake the friction of the hair with the stethoscope, during the act of respiration, for an intrathoracic sound. This fallacy may be avoided by wetting or shaving the part, or having the bell of the stethoscope shod with a piece of India-rubber. *The differential stethoscope* of Dr. Scott Alison may occasionally be employed in the physical examination of the lungs, but it is of much more importance in cardiac diagnosis, especially in determining the rhythm of murmurs. It consists simply of two stethoscopes, with flexible stems, leading separately to each ear, and connected by a joint. The ear-pieces are small and fit into the ears, while the flexible stems allow of the bells being placed at a greater or less distance from each other according to the desire of the auscultator. A new form of differential stethoscope has been introduced by Dr. Spencer, in which the sounds from each tube are communicated to both ears. A binaural stethoscope with a single bell is also frequently used, and is said to intensify the sounds.

During auscultation both the patient and the observer should be in an easy posture. The patient should lie quite flat or sit unconstrainedly, all muscular effort being in abeyance, and the auscultator should avoid stooping or straining too much over the patient. A very thorough examination can also be made with the patient standing erect, a blanket or shawl being cast over his shoulders to prevent any chill. The examination should be carried out quietly and systematically, the various regions of the chest being, as far as possible, symmetrically examined and carefully contrasted. It is often necessary also to contrast different parts on the same side. The patient should be directed to breathe quietly or forcibly, according as circumstances demand, and it is well in most cases to listen under both conditions, always taking care, however, that quiet respiration is first selected. A fact of importance is, that forced inspiration should not be performed spasmodically, or with noise in the mouth or nose, but slowly and quietly. A thorough examination of all parts of the lung is necessary, but special attention should be paid to the apex, both in front and behind, to the axillary region, to the interscapular region, to the base behind, and to any region where pain is complained of. The student must be careful not to confuse his ear by lingering too long over the same spot; it is much better to return to it. The examination should be conducted with as little fatigue to the patient as possible, and with this end in view, as well as to avoid unnecessary repetition, each spot on the one side should be compared with a corresponding point on the other: exact comparative results are thus obtained.

The principal objects for which auscultation of the lungs is practised are: 1, To ascertain the condition of the respiratory murmur or breath sounds; 2, To detect the presence of any superadded abnormal sounds or râles; 3, To ascertain any alteration in the resonance of the voice and cough, or in the transmission of the heart's sounds.

BREATH SOUNDS.

To ascertain the condition of the breath sounds. In this as in all other departments of physical diagnosis, the student must be acquainted with the healthy phenomena before he can hope to detect morbid changes. There are three facts then with which he must make himself perfectly familiar in the healthy chest, viz., the character of the breath sounds as heard over the trachea, over a bronchial tube, and over the spongy lung tissue. The breath sounds *over the trachea* are loud, hollow, articulate, and the expiration and inspiration are equal in length and intensity, but separated by a distinct interval. *Bronchial respiration* is heard to greatest advantage near the sterno-clavicular articulations or in the interscapular spaces near the spine. It approximates in character to the tracheal, but is much less pronounced.

The vesicular or respiratory murmur proper is heard over the spongy lung, and may be found in its most typical form in the lower half of the back, two or three inches from the spine, or in the lateral region. It is soft, breezy, and uniform; and although the inspiratory and expiratory sounds are the same in quality they differ in degree and prolongation, the expiratory being less loud and only about one-third the length of the inspiratory. The interval between the two acts is of very short duration. It is to be remarked that the inspiratory murmur is normally louder and harsher in children than in adults (hence called *puerile*), that in old age it tends to become feebler, and that it is usually more marked in men than in women. It is also to be expected that in an emaciated subject the respiratory murmur will be more audible than in one with well-developed muscular and fatty tissues. Besides these there are variations which cannot be accounted for on any physical principle, and may be regarded as individual peculiarities, some men having an extremely feeble, or almost inappreciable respiratory murmur throughout the chest, while others have respiration which may almost be described as puerile, both conditions being quite compatible with an absolutely normal state of the lungs and air passages.

The vesicular murmur may undergo various changes in disease. It may become *weakened* or *suppressed.* Weakening of the respiratory murmur may result from some obstruction, such as pressure of an aneurism on a bronchus, or spasm of a bronchus; or from some obstruction in the larynx and trachea hindering the free admission of air into the pulmonary vesicles. The pain of pleurisy, by impeding the free movements of the chest, may lead to partial restriction of the respiratory murmur. It may also result from pulmonary condensation, collapse, or emphysema. Absolute suppression occurs in cases of large effusion either of serum (hydrothorax), or of pus (empyema), or of air (pneumothorax), into the pleural sac. In certain cases of condensation and collapse of the lung, the respiratory murmur may be quite suppressed or replaced by some other form of respiration, such as the bronchial.

The respiratory murmur may be *exaggerated*, or as it is technically called *puerile.* This exaggeration specially affects the inspiratory murmur. In children the normal respiratory murmur is of this type, but in the adult its presence usually indicates that although the part of the lung over which it is heard may be healthy, some other part is suffering from causes leading to suppression or diminution of the respiratory murmur. It is heard at the apex of a lung, for instance, when the lower part is compressed by pleuritic effusion, or when the base is consolidated; or if owing to any cause the function of one lung is much crippled, the respiratory murmur is often exaggerated on the other side. All these facts indicate its compensatory nature.

Jerky, wavy, sighing, or cogged-wheel respiration, is the term applied to the respiratory murmur when it loses its continuous character and gets broken up into parts, or into a series of little waves. It is the inspiratory murmur almost exclusively which is affected in this manner. It is not indicative of any positive disease, but should always be regarded with suspicion, especially if it is localized at the apex, as an early indication of phthisis. In many instances in the vicinity of the heart jerky respiratory murmur is obviously pulsatile, and due to the cardiac action.

Prolongation of the expiration. It has already been stated that normally the expiratory murmur is much shorter than the inspiratory, but in many cases it becomes so lengthened as to equal the inspiration, and in some instances even to exceed it. It is a frequent indication of the early stage of tubercular deposition, and in such cases is usually associated with a degree of harshness or exaggeration of the respiratory murmur. In vesicular emphysema, owing to over-distention of the air vesicles and consequent loss of elasticity in their walls, this prolongation of the expiration is very marked, and is associated with weakening of the inspiratory murmur.

But the respiratory murmur, besides these alterations in it, may come to assume a totally different quality; it is replaced, in fact, by breathing of another type. The changes in quality are indicated by the terms *tracheal, bronchial or tubular, cavernous, and amphoric.* Some of these differ only in degree, and all of them may be heard at different stages in a case of phthisis going on to excavation, as well as in other affections having a similar tendency.

Bronchial or tubular respiration, as has been already stated, is heard in the healthy subject over the large bronchi, but in certain forms of disease it is present over the spongy lung. It occurs in consolidation and collapse. It is heard in pneumonia during the stage of hepatization, in phthisis, and in cancer of the lung. It is occasionally also heard in pleuritic effusion: in cases with large effusion, where the lung is squeezed to the upper and back part of the chest, bronchial respiration is often heard in this situation.

Cavernous respiration has the same hollow and articulate quality as that heard over the trachea, and if these characters are present over a limited area and not in the immediate vicinity of a bronchial tube, and especially if associated with the metallic phenomena (to be afterwards described), the probability is that a cavity exists. All conditions that lead to excavation in the lung tissue produce it, and among these phthisis is by far the most frequent. Dilated bronchi may also give rise to it. *Amphoric respiration* is just a more exquisite degree of the cavernous, and can be well imitated by blowing across the mouth of a large empty jar. It is heard in large intra-pulmonary cavities, and in cases of pneumothorax where there is a communication between the lung and the pleural sac. Guttmann maintains, however, that it is produced in pneumothorax only when the pulmonary fistula has closed, and the lung is still capable of a certain amount of expansion. (See also p. 556.)

RALES.

The respiratory murmur may be accompanied or replaced by other sounds called râles. These may be classified as—(1) sonorous and sibilant; (2) mucous or bubbling; (3) crepitant. Friction sound is not usually classified among the râles, but, in many instances, it so closely resembles, or is so closely simulated by, intra-pulmonary sounds, that it seems well to treat of it in this connection. Various combinations of these râles occur and must be named accordingly.

Sonorous and sibilant râles. These are dry and somewhat musical; they are caused probably by some obstruction to the tide of air in the bronchial tubes. The sonorous or snoring râles are of a grave pitch, loud, and usually accompany both inspiration and expiration, but the pitch may vary in the two acts. The sibilant (wheezing, whistling, cooing, etc.) are high in pitch, but in other characters resemble the sonorous. These râles are heard most typically in acute and chronic bronchitis, and in spasmodic asthma. The two forms of râle are usually associated; they vary much from time to time, and may disappear temporarily after a cough.

Bubbling or mucous râle. This râle, in its typical form, unquestionably gives the ear the impression of moisture, like the bubbling of air through some viscid fluid. It often exists both with inspiration and expiration, and varies greatly in its degree, sometimes approaching to the characters of the crepitant râle, and then called "sub-crepitant" by some authors, while at other times it is large, coarse, and quite decidedly mucous. It may, in severe cases, be present all over the lung, but, as a rule, is most abundant at the base. It is common in bronchitis where the secretion of mucus is abundant; in œdematous states of the lung owing to disease of the heart or kidneys; and in certain fevers, such as typhus, owing to congestion. In the stage of resolution in pneumonia the râle known as the *crepitus redux* is essentially a mucous râle, and the *clicking râle* of phthisis is also moist. This râle in phthisis is so significant as to demand special mention. It is very distinctly moist and clicking, often very scanty, limited in its area, chiefly accompanying inspiration, sometimes only toward termination, and having a marked tendency to develop at the apices. It is very significant of softening tubercle. *The cavernous râle* may also be considered as a modification of the mucous. It is present in cases of cavity from tubercular disease or dilated bronchi. It usually accompanies both expiration and inspiration, is heard over a limited area, and if the patient coughs it often has a splashing or gurgling quality, each splash being followed by an aftertone or echo.

Crepitant râle. This is a finer râle than the mucous, and is not distinctly moist. It is heard in its typical form in the first stage of pneumonia, prior to consolidation, when it constitutes the *pneumonic crepitus.* This is heard, as a rule, on inspiration only, often just at the end of it, and consists of a number of minute crackles. It can be well simulated by rubbing a lock of hair between the fingers near the ear. The râle is extinguished on the supervention of bronchial respiration. Crepitant râle is also present in œdema of the lungs, and acute capillary bronchitis, and certain forms of pleuritic friction often closely resemble it. It merges by insensible gradations into the sub-crepitant râle, or very fine moist or mucous râle.

Friction sound is produced in the pleura, owing to the roughened surfaces grating on each other, and in its most exquisite form it is easy of recognition. It is distinctly rubbing or grating, very superficial, and usually accompanies both expiration and inspiration, but it may be with inspiration alone. It is often quite appreciable by the hand of the observer (pleural friction fremitus), and the patient even may be conscious himself of the grating in his chest. Its most frequent seats are in the mammary region, in the lateral region in the line of the axilla, or further round, near the inferior angle of the scapula. It is often accompanied by an unchanged condition of the respiratory murmur, but this may be somewhat weakened or jerky; forced inspiration and coughing do not obliterate it; indeed, forced inspiration is often required to bring it out. In many cases its characters are not so pronounced, and it is often mixed up with intra-pulmonary râles, which tend further to obscure the diagnosis. In some cases friction is caused in a roughened pleura by the cardiac action. This is heard on the confines of the heart, and is distinctly related to the cardiac action, as may be found by its continuing when the patient suspends respiration.

TALLIC AND AMPHORIC PHENOMENA.

t a certain group of auscultatory signs which
l under the title of metallic phenomena. These
nkling, amphoric echo, the bell sound, and Hip-
ssion. All these phenomena are very variable
e and persistence, and they occur in different

ling is well described by Laennec as "a peculiar
bears a striking resemblance to that emitted by
l, glass, or porcelain when gently struck with a
hich a grain of sand is dropped." It may be
spiration, voice, or cough—most typically with
It is very significant of cavity, and may be
pulmonary excavations when near the surface
d also in pneumothorax.

ho. This term is applied when the voice,
ath sounds have an intensely hollow resonance,
vell imitated by speaking, coughing, or breath-
ge empty jar. It very frequently accompanies
ing, or may be interchangeable with it. It is
hen large masses of air are thrown into vibra-
rs most frequently in pneumothorax, although
nally be heard in intra-pulmonary cavities of
may accompany respiration, voice, or cough.

VOCAL RESONANCE AND FREMITUS.

The next point in the examination of the lungs is to ascertain any alteration in the vocal resonance or fremitus, or in the transmission of the heart's sounds.

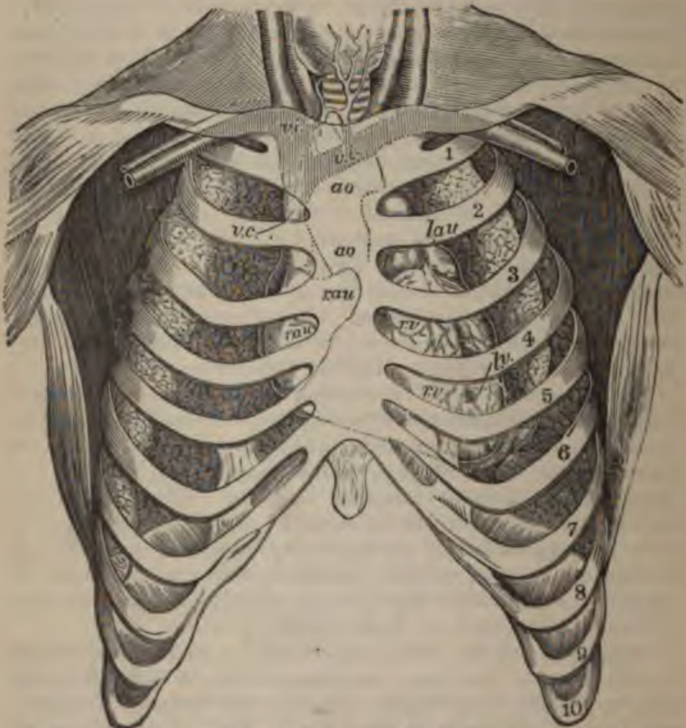
Vocal resonance is the term applied to the vibrations caused by the voice of the patient transmitted through the chest to the ear of the auscultator. It is best elicited by causing the patient to say such words as "twenty-one," "twenty-two," "twenty-three," in his natural voice. It is, as a rule, most distinct in adult males, especially if the voice is grave in pitch, but it is subject to such variations, that in the absence of other signs of disease little diagnostic importance can be attached to it. It is well to recollect, also, that even in health it is louder in most cases at the apex of the right lung than of the left. Over the spongy lung the vocal resonance is simply an indistinct buzzing, but if listened to over the trachea, it is found to be loud and near the ear, every syllable is quite appreciable even when whispered. This is almost identical with *pectoriloquy*, in which the sounds appear to be transmitted directly into the ear from the chest. Over the site of the larger bronchi the voice possesses a less degree of distinctness and intensity, and to this is applied the term *bronchophony*.

In disease the vocal resonance, over the area of spongy lung, may approximate to *bronchophony* or *pectoriloquy*. The change in the direction of bronchophony depends chiefly on consolidation, and is often present in pneumonia, phthisis, and other condensations. Laennec believed pectoriloquy (but only in that degree which he termed "perfect pectoriloquy") to be pathognomonic of cavity in the lung, and no doubt it is a frequent associate of this condition, and a valuable fact in conjunction with other signs, but it may also be heard in cases of consolidation, such as those mentioned above.

Ægophony was the name applied by Laennec to a peculiar modification of the vocal resonance which is high in pitch, very tremulous, and closely resembles the bleating of a goat, or the voice of Punch in the puppet show. It is not often found in perfection, but degrees of it are not uncommon, and its most frequent site is near the inferior angle of the scapula. Laennec thought it depended on the interposition of a thin stratum of fluid between the layers of the pleura, but it is also found in the course of pneumonia, and in inflammatory thickening of the pleura. Its cause is still a matter of dispute.

Autophony is a term used to denote the resonance of the auscultator's voice if he speaks while he has his ear applied to the patient's chest. He may hear the tones of his voice intensified on the one side as compared with the other. This phenomenon is heard more or less in most of the cases where bronchophony is developed, but it is chiefly marked in cases of large cavity, and especially in pneumothorax.

FIG. 101*.



Position of thoracic organs (Luschka). Compare also Fig 156. The outlines of organs partially invisible in the dissection are indicated by very fine dotted lines.

Reference letters:—r. au. = right auricle; a. o. = arch of aorta; v. i. = the two innominate veins; v. c. = vena cava descendens; p. = pulmonary artery; l. au. = left auricle; l. v. = left ventricle; r. v. = right ventricle.

The *vocal resonance may be absent* in certain cases, and this is an important fact if the resonance was known to have existed previously; or it may be absent only on one side or at one part. This points to some obstacle to the transmission of the sound, chiefly owing to fluid effusion or some obstruction in the bronchial tubes.

For amphoric voice in pneumothorax, see page 556.

The *vocal fremitus* is closely allied to vocal resonance. It is the sensation appreciated by the hand placed on the patient's chest while he speaks. This is also subject to great variation, consistent with perfect health, but it may be stated as a general rule, that conditions leading to increase or diminution of the vocal resonance apply to vocal fremitus. It is thus generally increased in consolidation of the lung, and diminished in pleuritic effusion.

In certain diseased conditions of the lungs the heart's sounds may be transmitted widely over the pulmonary area. This is especially the case in all forms of consolidation, and when this transmission is to the apices of the lungs, and especially to the right, it is often significant of phthisical consolidation. The heart's sounds may be altered in quality owing to diseased ·conditions in the lung, but these will be noticed under the physical diagnosis of the heart.

PART II. PHYSICAL EXAMINATION OF THE HEART.

In the physical examination of the heart, the same methods of investigation are employed as in the case of the lungs, viz., *inspection, palpation, percussion, and auscultation*. The cardiograph and sphygmograph yield also valuable information as to the state of the heart in many instances.

It is of great importance for the beginner to practise frequently the

EXAMINATION OF THE NORMAL HEART.

The first point of importance for the student to note is the *contour of the chest-wall* in front of, and inclosing the organ. In the healthy chest the left is usually symmetrical with the right side, but, as will afterward be seen, certain diseases may cause alterations in respect of this symmetry, which may have a diagnostic importance. Having inspected the precordial region, and having noted the fact of *any visible pulsation*, whether diffused over the cardiac area, or limited to the apex-region, the epigastrium, or other part of the chest, the next point to determine, if possible, is the exact *position of the apex-*

beat. In many cases this corresponds with a visible pulsation which may have been noted in the preliminary survey, but in not a few instances no such distinct pulsation is seen, and careful search by palpation must be made for the apex. In all cases, whether there is a visible apex-beat or not, the intercostal spaces in the precordial region should be separately examined with the tips of the index and middle fingers, in order to fix, if possible, the exact spot at which the apex, or rather the most superficial part of the left ventricle, strikes the chest-wall. The most favorable opportunity for this is in expiration, when, by the recession of the lung, the heart approaches most closely to the ribs; but the state of expiration must not be too long maintained. (See foot-note, p. 646.)

In the normal chest, in the recumbent posture, the apex-beat is usually found in the fifth intercostal space, slightly inside the vertical line of the nipple.[1] It is to be remembered, however, that the site of the nipple varies to some extent, even in males, and in women its position is ruled by the degree of development and laxity of the mamma, and so its relation to the apex-beat is by no means constant. The usual position of the apex-beat is as above indicated; but in not a few instances, even in healthy subjects, no distinct impulse exists while the patient is in dorsal decubitus, and only a comparatively feeble pulsation is felt in the fourth or fifth intercostal space. In such a case the patient should be turned on his left side well round on his face. This change in posture favors the gravitation of the heart to the surface of the chest, and to the left side, so that an apex-beat, almost imperceptible in the recumbent position, may now become distinct. Under such circumstances, allowance must be made for its being carried more to the left, but the degree of this varies in different subjects, according to the laxity of the tissues which bind the heart. A cardiac apex-beat inappreciable in the recumbent posture may also be made apparent by causing the patient to sit up and lean somewhat forward. Percussion may assist in determining to some extent the site of the apex, as it is usually found immediately inside the left border of the precordial dulness. But the student should also use the stethoscope in aid of palpation in determining this most important fact, and it is specially useful where no tangible apex-beat exists. For this purpose he should auscultate in the apex-region till a spot is found, over which the first sound of the heart has the most definite and superficial character, and this may be assumed to be the point at which the wall of the left ventricle comes nearest to the surface.

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[1] Or midway between the vertical line of the nipple and the "parasternal line," which is an imaginary line falling midway between the margin of the sternum and the nipple line.

Having determined as nearly as possible the position of the apex-beat, it should be marked (with ink or pencil), and the next step is to appreciate thoroughly *the nature of the impulse.* This can be done either with the tips of the fingers or the ball of the thumb, the former, however, yielding the more definite results. In healthy subjects, in whom a tangible apex-beat exists, it is precise and definite, the area of visible impulse not exceeding a square inch; and in those in whom it is not present in the recumbent posture, but is developed when they are laid over on the left side, it presents similar characters. Changes in neighboring organs may have so altered the relations of the apex as to obscure its impulse in all positions, and such a condition is to be noted, but it does not necessarily indicate disease of the heart. A definite apex-beat may also be wanting in healthy subjects from the fact that the impulse is delivered against a rib instead of an intercostal space.

In the strictly healthy subject no considerable impulse exists over the right ventricle, but a degree of this can be educed by sudden exertion, and it may be discriminated from the apex-beat. This impulse or heave is best appreciated by the ball of the thumb or pulse of the hand placed over the region of the right ventricle. It can also be well appreciated by the direct application of the ear when the impulse is communicated to the head. The student should notice this impulse carefully, as in some diseased conditions it is of much diagnostic value. In widely diffused impulse the point furthest to the left, giving a distinct and direct impulse, is to be regarded as the most probable site of the apex, but it does not necessarily follow in such cases that the apex of the left ventricle produces any sensible and separate impact at all.

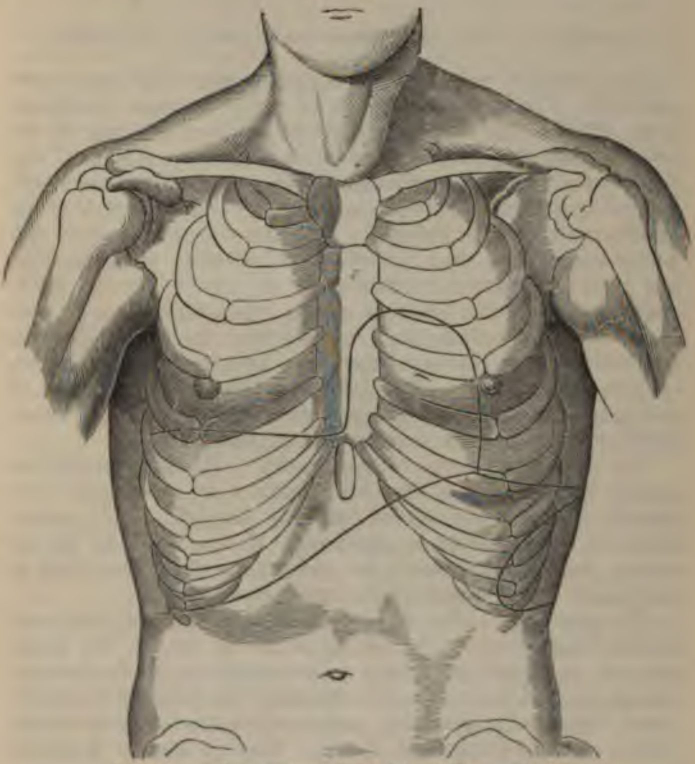
Percussion of the heart is the next step in the examination. In women in whom the mamma is large and flabby it should be drawn up or to one side while the percussion is being followed out. The area of precordial dulness will vary somewhat according to the strength of the percussing stroke. If the deep or relative percussion dulness is wanted, a comparatively strong stroke is necessary, and the percussion should be made as far as possible during expiration, while the heart is most uncovered. If, however, the superficial or absolute dulness is required, the lightest possible stroke should be employed, in order to determine accurately only that part of the heart which is uncovered.

Even with light percussion, however, the portion of heart uncovered by lung cannot be delimited with *absolute* accuracy, inasmuch as the layer of lung having become so thin near its margin the pulmonary resonance is modified by the solid organ beneath, which, although overlapped, diminishes the resonance in the area controlled by the percussion stroke.

If the object is to estimate the size of the heart, the area of percussion dulness is best mapped out by a stroke just sufficient to bring out a perfectly distinct pulmonary note, and the point where the first diminution in the resonance can be detected should be marked as the boundary. Different observers may mark out the cardiac dulness in a given case with very different results as regards the mere marking, although probably with little difference as regards the inferences they draw concerning the size of the heart—each observer having become familiar with his own method as applied to normal as well as abnormal conditions. The student must aim at establishing some such standard for himself whatever may be the method he is taught. From practice on normal hearts he will arrive at a standard of percussion-dulness from which safe inferences may be drawn in cases of disease.

In the delimitation of the heart, it is best to begin percussion over the pulmonary area in the immediate vicinity of the organ and travel inward. Commencing then with the right border, the student should appreciate thoroughly the clear note over the right lung and then percuss through the middle line, noting the point at which the clear pulmonary note becomes modified. Having marked out the whole of the right border in this manner he should proceed to the left, to which the position of the apex-beat will afford a guide. To delimit the upper border, percussion is to be made from the left infraclavicular region downward, The lower border of cardiac dulness cannot, as a rule, be separated from that of the liver. It is useful to indicate these limits of percussion-dulness by marking them with ink or pencil. The right border of the dulness as thus ascertained will be found usually to coincide pretty exactly with the mesial line (although with very strong percussion it may pass in the right of that line from one inch and a half to two inches). The left border, as a rule, coincides with a line about half an inch outside the apex-beat, and so corresponding nearly with the vertical line of the nipple. The upper margin of dulness is usually near the lower border of the third rib, and it curves downward to join the left margin. (See Fig. 102.) The transverse measurement of this

FIG. 102.



Area of normal percussion-dulness of heart, liver, and spleen. (Slightly modified from Weil.)

area of normal percussion-dulness as described may be stated approximately at from three to four inches in the adult male. In women it is less, and it will vary according to the build and stature of the subject. While performing the percussion attention should be given to the sense of resistance to the percussing stroke, as the presence of increased resistance may assist the diagnosis. In many instances, however, the delimitation of the cardiac dulness is interfered with by the occurrence of consolidation in either lung in close proximity to the heart, or by the presence of fluid in the pleuræ.

The sounds of the normal heart are discussed at p. 572.

CHANGES IN THE APEX-BEAT—ABNORMAL PULSATION.

The apex-beat may become inappreciable, or at least much obscured. This is especially apt to occur in cases of copious fluid effusion into the pericardium, or from bulging of the anterior margins of the lung in emphysema. Again, if the right ventricle is much dilated it pushes the left into the background and hinders it from reaching the surface, so that no precise apex-beat is present.[1] In extensive adhesion of the pericardium also, there is often no distinct apex-impulse, but rather a systolic retraction of one or two of the intercostal spaces in the vicinity of the apex-region, or it may be of the whole chest wall in children, in whom the ribs are yielding; at the same time the heart has often a jogging or tumbling action. The absence or want of precision of the apex-beat may thus indicate disease either of the heart itself or of some of the neighboring organs.

The *apex-impulse may be exaggerated*. This is generally the case in hypertrophy of the left ventricle, in which also it is usually displaced downward and to the left. All causes, however, which produce overaction of the heart, as, for instance, mental excitement or violent exertion, may lead to temporary exaggeration of the apex-impulse.

The apex-beat is often displaced. It may be found displaced *downward and toward the left*, so as to be felt in the sixth, seventh, or eighth intercostal space, several inches outside the nipple line. Under such circumstances the impulse is usually much increased in intensity, and so widespread as to be visible in two or three intercostal spaces. This is usually found in hypertrophy of the heart, involving the left ventricle chiefly.

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[1] Apart from diseased conditions altogether, a very simple experiment which anyone can make on himself, will demonstrate the effect which a distended right ventricle has on the apex-beat. When lying in an easy position a finger is put on the apex-beat, and its character carefully noted, while with the other hand the pulse of some of the arteries is felt. Respiration is then simply suspended without any deep preliminary inspiration. As the sense of suffocation approaches, the apex-beat grows gradually more indistinct, and may even disappear, while the heave of the right ventricle becomes more marked. The pulse, however, is not affected to any extent, except perhaps being a little smaller, and this shows that the left ventricle is still contracting quite efficiently although the apex-impulse has become obscure; owing to the repletion of the right ventricle, the left is, as it were, thrown behind and cannot reach the chest wall. When respiration is resumed the apex-beat becomes apparent at once. These conditions are quite independent of the expansion of the lung, being equally appreciable in inspiration or expiration.

The apex-beat may come to be *displaced upward*, owing to pressure on the diaphragm from ascites, tympanites, and solid or cystic tumors of the abdominal organs; or it may be dragged upward by a shrinking of the left lung, as in phthisis with contracting cavities in the apex, or from retraction of one side of the chest after the absorption of an effusion. In considerable pericardial effusion the apex-beat is apt to be raised, and the same is said to occur in cases of adherent pericardium. It may be found *displaced either to the right or left* by fluid or air in the pleuræ (hydrothorax, empyema, or pneumothorax). The displacement is much greater when the effusion is in the left pleural sac, and, if it is extreme, the heart may be found beating under the right nipple. This condition has been called *dextiocardia.* (See Fig. 106.) The impulse, however, which is felt in such a case is not from the apex of the left ventricle, but from some part of the right. The heart may remain displaced even after the effusion disappears, through the influence of adhesions.

Changes in the character of the apex-impulse are also to be noted. It may become unduly strong and heaving in hypertrophy, or weak in cases of dilatation and fatty degeneration. Its regularity, or the reverse, in rhythm and force, must also be attended to.

Centres of pulsation other than the apex-beat may become developed in diseased conditions. In certain cases, coincidently with a want of distinct apex-beat, there is an undue development of the *impulse or heave over the right ventricle.* This is especially the case in hypertrophy and dilatation of the right side of the heart. There is then appreciable over the region of the right ventricle a diffused impulse which is often propagated into the epigastrium, through the left lobe of the liver, in the form of a wide-spread pulsation; and in certain cases of displacement of the heart, as, for instance, downward and inward from emphysema, even a more direct impulse may be felt there. As this *epigastric pulsation* is always important, it should be sought for, not only by placing the flat of the hand over the pit of the stomach, but also by inserting the tips of the fingers under the costal cartilages in the direction of the heart. This epigastric pulsation from the action of the heart must be distinguished from a pulsation communicated from the aorta, which is felt under certain conditions in the same region. The aortic pulsation can usually be traced along the vessel in the abdomen (not merely as a pulsating tumor, as in aortic aneurism there): and, by careful attention to its rhythm, it may be found to succeed the cardiac systole by a minute interval of time. This "throbbing aorta" is a frequent fact in anæmic or nervous conditions. (See p. 341.) Aneurism of the abdominal aorta, or of some of its branches, may also give rise to pulsation in the epigastrium, but the sense of tumor and other signs will usually guide the diagnosis. In certain instances of very free tricuspid regurgitation, pulsation, synchronous with the cardiac systole, is felt in the liver.

When the base of the heart is uncovered, owing to retraction of the edge of the left lung, as in phthisis pulmonalis, the roots of the great vessels, and especially of the pulmonary artery, as it is most superficial, are exposed, and as it usually happens in such cases that the patient is much emaciated, a pulsation which corresponds with the expansion of the pulmonary artery can sometimes be felt and even seen. It is situated about the second left intercostal space, near the margin of the sternum, is very restricted in its area, and, in addition to the implse, the finger is conscious of its being succeeded by a snap and sudden recoil, coincident with the closure of the sigmoid valves. In rare instances, pulsation from the auricle exists in this situation, but the impulse in such a case precedes the apex-beat, and is succeeded by no snap. Simultaneous tracings of the cardiac apex-beat and the abnormal pulsation in such cases may be taken with the polygraph, and will at once resolve any difficulties that may arise as to its being due to auricle or pulmonary artery. The aorta is too deeply seated to give any definite impulse externally in the normal conditions, but when aneurismal disease of its thoracic portion exists a pulsation may be produced which can, as a rule, be quite easily separated from that of the heart.

Pulsation in the vessels of the neck. The jugular fossa should be explored by inserting the tips of the fingers down behind the sternum, the patient being directed to bend the head forward, so as to relax the tissues. Undue pulsation sometimes associated with a sense of resistance or tumor there, chiefly due to aneurism, or at least dilated aorta, is often met with in this situation. The trachea may be found displaced somewhat backward, or to either side in such cases. The state of the jugular veins is also to be noted, pulsation in them being a frequent associate of valvular disease of the right side of the heart. Such pulsation, however, is not necessarily a serious matter; it merely indicates regurgitation of blood back into the veins, the valves at the root of the neck being incompetent, perhaps from distention of the vessel. This may occur in health, though usually only to a slight degree and without any distention or other abnormal symptom; the impulse of the auricle (perhaps also of the right ventricle) being transmitted directly through veins with congenitally imperfect valves. In some instances, although there is no actual pulsation in the vein, it receives a movement from the artery lying underneath it, so as to simulate this: the way to solve the difficulty is by pressing very lightly on the vein at the root of the neck, and so occluding it, and if under these circumstances the pulsation ceases, the inference is that the action is in the vein, while if it continues it is most probably due to the heave of the carotid. The pulsation in the veins of the neck can usually also be recognized as different in character from a transmitted arterial impulse, being, as a rule, much more wavy. Tracings can sometimes be taken of this venous pulse in the neck; their characters and interpretation will be found elsewhere. Retraction of the veins of the neck during the cardiac diastole should be looked for, as it is said to occur sometimes in cases of adherent pericardium.

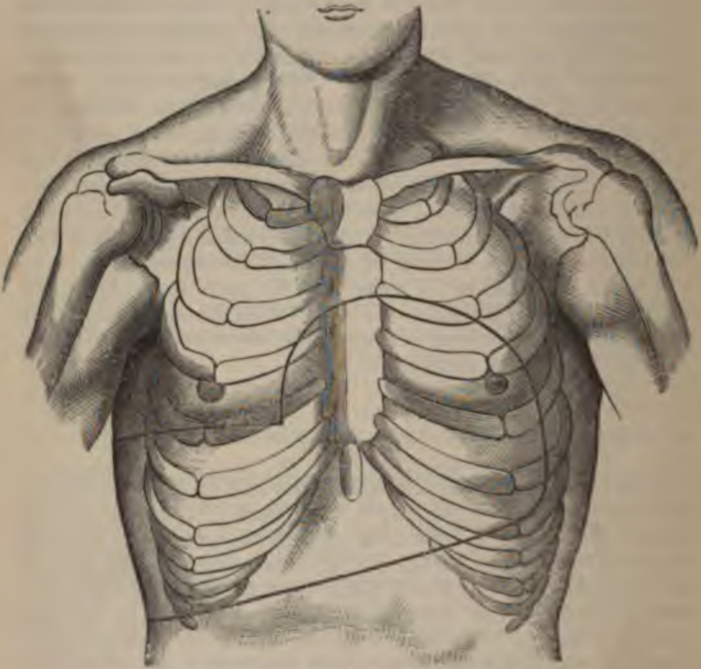
Undue pulsation in the arteries of the neck exists in exophthalmic goitre; in some cases of anæmic palpitation; in aneurism; and in aortic insufficiency, where the visible pulsation is often a very marked feature.

CHANGES IN THE AREA OF PRECORDIAL DULNESS.

The area of precordial dulness may be increased, diminished, or displaced. *Decrease* in its area is generally due, not to disease of the heart itself, but to changes in the lungs, and especially to emphysema, in which the anterior margins of the lung may become so distended as to mask the cardiac dulness to a greater or less extent. (See Fig. 157.) In emaciating diseases, however, the heart participates in the general atrophy, and this may lead to some decrease in the precordial dulness.

But *increase* in this area is much more frequent. If the increase is toward the left side and downward, and coincides with a strong and somewhat diffused apex-beat in the sixth or seventh interspace, or much to the left of its normal site, it most likely indicates hypertrophy of the left ventricle. If, on the other hand, the dulness extends chiefly to the right, the presumption is that the right ventricle is the seat of hypertrophy or dilatation, and this may be corroborated by the occurrence of a well-marked heaving action over the right ventricle, by an ill-defined apex-beat, and by the presence of pulsation in the epigastrium. If the dulness is increased pretty equally both to right and left, while the upper margin maintains its normal position, hypertrophy or dilatation of both cavities may be suspected (see Fig. 103); but if with lateral extension there is a conical prolongation of the dulness up in the direction of the first rib, there is ground for suspecting effusion into the pericardium. (See Fig. 104.) In all these cases there may be a degree of vaulting in the precordial region, but it is usually most marked in pericardial effusion, in which the percussion resistance is also greatly increased. *Apparent increase* in the

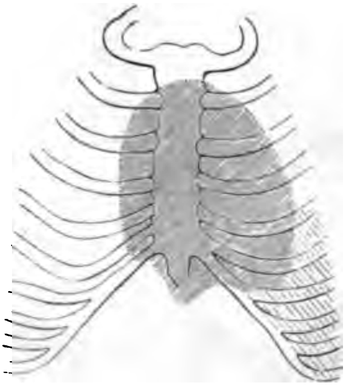
FIG. 103.



Cardiac dulness increased from hypertrophy of both ventricles.

dulness may arise from tumors, aneurismal, cancerous, or glandular, situated in the mediastinum; or from effusions into the pleuræ; or even from limited consolidations of the lung in the immediate vicinity of the heart. The diagnosis of aneurism may be made from the fact that the abnormal area of dull percussion is usually situated at the base of the heart, often at the manubrium sterni; it coincides in situation with the aorta and is sometimes joined to the cardiac dulness by only a narrow neck; a pulsation separable from that of the heart is often present over it, sometimes accompanied with thrill; the heart's sounds are also frequently changed in quality over the dull area, and sometimes associated with murmur. The diagnosis in the other conditions mentioned may be assisted by the fact that the cardiac sounds are normal in character, not coextensive with the dull area, and there is not the heaving impulse that might be expected were the extension due to dilatation or hypertrophy of the heart itself. The subjective symptoms will also afford valuable means of diagnosis

FIG. 104.

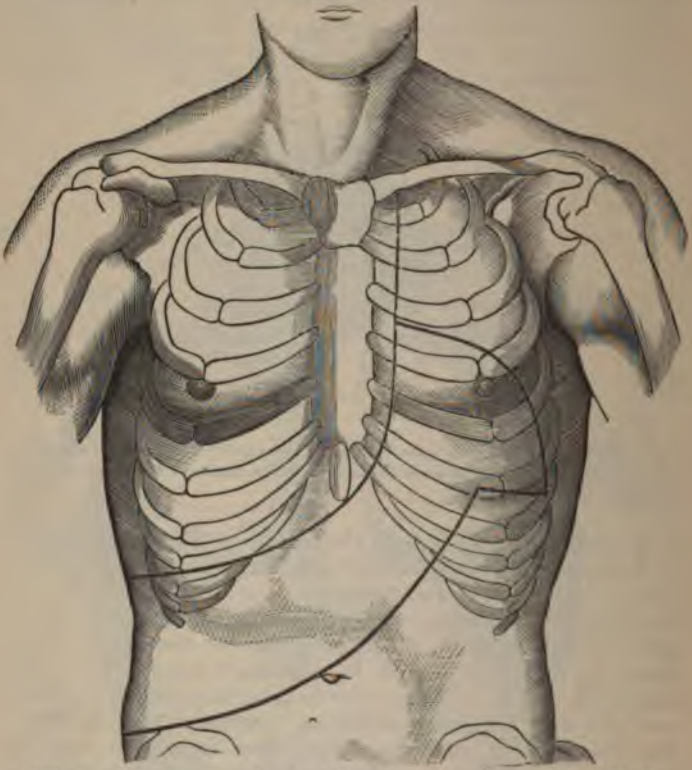


Percussion dulness in pericardial effusion; the lower and left margins left undefined, owing to their having been inseparable from the dull percussion of the abdomen and of the left pleura. (Gairdner.)

Displacement of the area of cardiac dulness either to the right or left may be due to pleural effusions of fluid or air, the displacement being always more marked when the left pleura is the seat of the disease. (See Figs. 105 and 106.)

Tumors in the thorax may displace the precordial dulness in almost any direction. A certain amount of displacement of the cardiac dulness is of habitual occurrence in emphysema of the lung, associated usually with some diminution of its extent also. (See Fig. 157.)

FIG. 105.



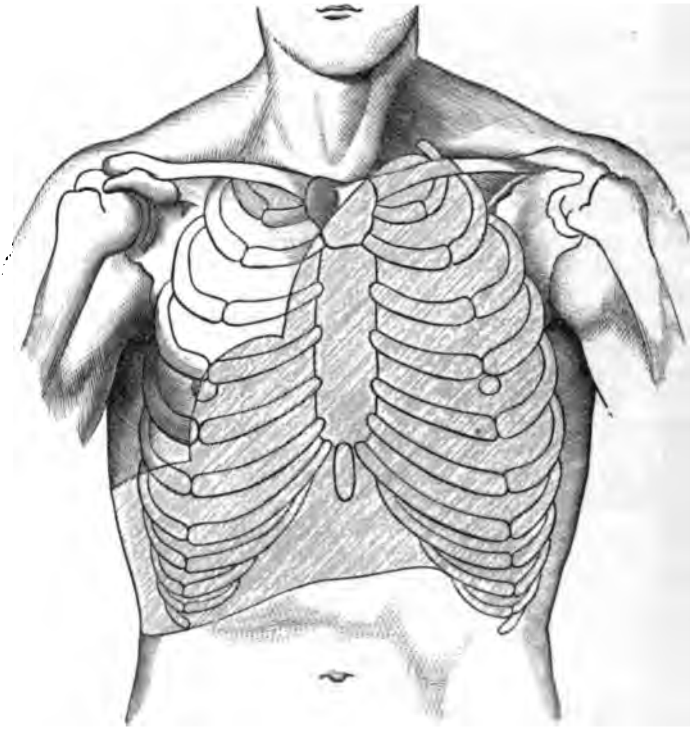
Displacement of mediastinum, heart, and liver from pneumothorax of the right side. (Weil.)

CARDIAC TREMOR OR THRILL.

In the palpation of the heart there is sometimes conveyed to the hand along with the impulse a sense of tremor or thrill

—"purring tremor." It is most frequently associated with valvular disease either aortic or mitral, and is quite distinct in its character from the sensation which is sometimes felt over the precordial region in pericarditis (pericardial friction fremitus), from the rubbing of the roughened pericardial surfaces on each other. This latter, when typical, has a harsh, rubbing, grating character, and does not, as a rule, possess the fixity as regards site and rhythm of endocardial thrills. The most usual sites of tremor are the apex and the base. When limited to the apex it is very characteristic of constriction or roughening of the mitral orifice, provided it can be felt imme-

FIG. 106.



Displacement of mediastinum, heart, and left lobe of liver from pleuritic effusion on the left side: the shading indicates the extent of dull percussion.

diately to precede the apex-beat. It coincides, in fact, with a presystolic murmur. In not a few instances, however, thrill in the apex-region coincides with the ventricular systole, and is due to regurgitation through the mitral orifice. When felt at the base, thrill is usually associated with disease (chiefly obstructive) of the aortic valves, but this is not invariably the case, as tremor often depends on aneurism of the first part of the aorta apart from any valvular lesion. Thrill is sometimes appreciable over the pulmonary artery also, especially where congenital stenosis of its orifice exists. Other conditions afterward to be indicated will guide the diagnosis in all these cases.

SOUNDS OF THE HEART, NORMAL AND ABNORMAL.

In auscultating over the heart the student will recognize two sounds which differ in character and in their sites of intensity. They are called the first and the second sounds. *The first sound* (systolic), which coincides with the ventricular contraction and the apex-beat, and immediately precedes the pulse in the neck, is dull, prolonged, and somewhat distant. *The second sound* (diastolic) coincides with no impulse, is shorter, clearer, sharper, and more defined, and agrees in point of time with the closure of the sigmoid valves of the aorta and pulmonary artery. The characters of the two have been represented by the syllables "*Lubb Tup*" The first is heard with greatest intensity over the apex-region and the ventricular area generally, while the second predominates over the base of the heart. Skoda indicates the intensity of the two sounds as heard at the apex and base, by saying that at the apex they form a trochee—lubb tup—and at the base an iambus—lub tup. This is not, however, invariably true. In a slowly acting heart there is usually no difficulty in distinguishing the two sounds from each other; they are defined not only by the characters above indicated, but also by the fact that the interval between the first sound and the second ("short pause") is much less than that between the second and the first—the diastole or "long pause" of the heart, as it is called, intervening. The following diagram (Fig. 107) indicates approximately the relations which the various periods in a complete cardiac revolution bear to each other. When, however, the heart is acting rapidly the shortening of the time is chiefly at the expense of the long pause, and then it may be a matter of difficulty to determine which is the first and which is the second sound; and this is all the more likely if either sound is so altered in character as to approximate to the other. The double stethoscope, however, will, as a rule, resolve this doubt, the one bell being placed over the apex and the other over the base. The different areas of intensity will also serve to differentiate the sounds.

Both sounds are complex, inasmuch as the first coincides with the contraction of the two ventricles and the second with the closure of the sigmoid valves of the aorta and pulmonary artery. The part of the first sound due to the left ventricle is heard with greatest distinctness in the apex-region, while that from the right side of the heart is most intense over the right ventricle near the sternum. The aortic element of the second sound is best communicated to a point at the junction of the second right costal cartilage with the sternum; hence this cartilage is often termed the "aortic cartilage." The pulmonic second sound is best heard near the junction of the third left costal cartilage with the sternum. In health, as a rule, the sounds at the apex and aorta predominate to a slight extent over those of the right side of the heart. Some assistance is also obtained from considering the relative intensity, in various circumstances, of the sounds as heard over the carotid and subclavian arteries, where the second sound may usually be regarded as identical with that produced by the closure of the aortic valves. But much care is necessary in founding conclusions on the above data.

The sounds of the heart may become (1) altered in character; (2) reduplicated; (3) associated with, or replaced by murmurs.

1. *Alterations in Character of the Heart's Sounds.*—In many exhausting diseases the sounds are apt to become *feeble*, and in the later stages of certain fevers, notably typhus, the first sound is especially weakened, and in extreme cases almost suppressed, while the second may remain tolerably clear and distinct. Fatty degeneration or infiltration of the muscular fibre of the heart naturally leads to the same result. In dilatation also the first sound fails in intensity and duration, and in some cases becomes clearer than normal, approaching the quality of the second sound.

Hypertrophy of the heart is usually associated with modification of both sounds. *The first sound becomes dull, prolonged, and sometimes even booming* in character, and should this change be most marked in the apex-region, the presumption is that the left ventricle is hypertrophied, while if it is present chiefly over the right ventricle it usually points to that cavity as the seat of the change. In either case the *second sound is unduly accentuated*, the alteration being recognizable as over the aorta or pulmonary artery, according to the cause of it. But the second sound may be accentuated and deepened in tone from other causes than hypertrophy of the ventricles. This may be present over the aortic cartilage in cases of high arterial tension in the systemic circulation, or in dilatation or aneurism of the arch of the aorta, or when the aorta has lost its elasticity from degenerative changes. Under these circumstances, however, a certain amount of hypertrophy of the left ventricle is, as a rule, also present. In all such cases the deepened tone is usually transmitted into the vessels in the neck. Over the pulmonary artery the second sound is accentuated in conditions which present an obstacle to the free passage of blood through the lungs. This change may be met with in pneumonia; and it is often a marked feature in cases of obstruction or regurgitation at the mitral orifice, lesions productive of increased tension in the pulmonary circulation, with more or less hypertrophy of the right ventricle. In certain cases, as in retraction of the upper lobe of the left lung from phthisis, the pulmonic second sound may appear to be morbidly accentuated when in reality it is simply brought nearer the ear from the artery having lost its covering of lung. In most of these instances, however, pulsation, both visible and tangible, is present over the artery, and the snap of the closure of the valve is often communicated to the hand. These conditions will help to guide the diagnosis. (See p. 566.)

When large air-filled cavities are in close proximity to the heart the sounds may take on a hollow, ringing, metallic quality, of the nature of an echo. The first sound is most frequently so affected, the causes being pneumo-pericardium, large pulmonary cavities, pneumothorax, or an over-distended stomach.

2. *Reduplication of the heart's sounds* arises from a want of synchronous action in the valves on the two sides of the organ, and so one or other sound is split up into its component elements. Either sound may be reduplicated, the second, however, being most frequently so, and there is then produced a "galloping" or "cantering action" of the heart, indicated by the syllables "*rat-ta-tat.*" The clinical significance of this fact is not always clear; and it occurs at times in healthy subjects. It will be sufficient for the student to note that, if it is best heard anywhere over the ventricular area, it is prob-

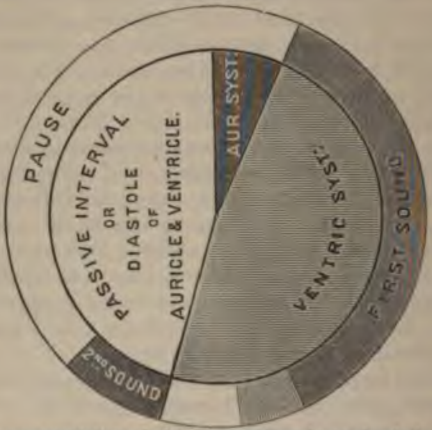
ably the first sound which is resolved into its component elements, while, if over the base, it is the second. Any condition which increases the tension either in the systemic or pulmonic circulation may disturb the balance of the two sides, and so predispose to reduplication. It is certainly a frequent fact in cases of Bright's disease, especially in the chronic granular form, although not infrequent also in the acute disorder; in these conditions increased tension in the *systemic* arteries is of well-known occurrence. On the other hand, increased tension in the *pulmonary* circulation is a necessary result of obstructive disease at the mitral orifice, and reduplication of the second sound is, therefore, often found in this affection; so frequent is it, indeed, that even in the absence of auriculo-systolic murmur at the apex, it has been looked upon by some authorities as strong presumptive evidence of mitral stenosis, especially when the pulmonic second sound predominates over the aortic. Even holding the breath for a long time may induce reduplication in the healthy subject. The impediment to regular and equable action presented by incipient pericarditis may also give rise to a "cantering action." Reduplication may be complete, with the two elements of the sound quite distinct; or incomplete, where there is no distinct interval, the sound appearing only lengthened and slurred ("*turrup*"). In some instances both sounds are reduplicated.

3. *Cardiac Murmurs.*—The sounds of the heart may be associated with, or replaced by, murmurs. These may be produced either within the heart (endo-cardial) or outside of the heart (exo-cardial), and may present a great variety of acoustic characters (blowing, rasping, cooing, etc.). The two most important facts to determine about them are (A) their rhythm, and (B) their site, or area of distribution. As so many cardiac murmurs are valvular in origin, it is on the whole a good rule to try all murmurs which require detailed investigation by the tests of the valvular murmurs before proceeding to any other.

A. Rhythm of Cardiac Murmurs.

What has to be considered under this head is the relationship, in point of time, which the murmur bears to the different physiological acts which constitute a complete cardiac revolution, viz., the contraction, dilatation, and rest of each of the cavities. (See Fig. 107.) The murmur has to be defined as occurring during this or that portion of the heart's action, or during the pause which intervenes between the periods of activity. To do this it is necessary to watch carefully its relation to the sounds, to the impulse, and to all the other appreciable phenomena which attend upon the action of the heart.

FIG. 107.



Diagrammatic representation of the movements and sounds of the heart. (After Sharpey.) This diagram shows merely the general relations of the several events, and does not represent exact measurements.

In a heart beating seventy-two times a minute, Foster estimates each entire cardiac cycle as occupying about 0.8 sec.; of which 0.3 sec. represents the duration of the systole of the ventricle, 0.4 sec. the diastole of both auricle and ventricle, or the "passive interval," and 0.1 sec. the systole of the auricle.

Only one "pause" is marked here—sometimes called the "long pause:" some writers describe a "short pause" also—indicated in the diagram by the small space between the first and the second sound.

Every valvular murmur has one of three relations to the sounds of the heart (complex murmurs, with two or more murmurs combined, will be considered later).

(1) *The murmur precedes and runs up to the first sound*, ending at the moment of this sound, and of the beat of the apex. In this case the murmur is synchronous with the contraction of the auricles, and is called *auricular-systolic*,[1] or by some

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[1] The terms here applied to murmurs, viz., "auricular-systolic" (A.S.), "ventricular-systolic" (V.S.), and "ventricular-diastolic" (V.D.), have become the habitual nomenclature in the Glasgow School, and what is meant by calling a murmur, a thrill, or other phenomenon, "A.S.," "V S.," or "V.D.," is that it coincides in point of rhythm or time with one or other of the periods of the heart's action, which is thus

presystolic (from its preceding the systole of the ventricle). The interpretation of such a murmur depends on its *occurring only when blood is being expelled from an auricle*, and when the ventricle is still passive. With very rare exceptions such a murmur depends upon constriction of, or obstruction at, the auriculo-ventricular orifices, with consequent interruption to the flow of blood out of the auricle during its contraction. It is thus said to be a *direct* or *onward* murmur; it is usually very rough in character and often accompanied by a thrill. (See p. 569.) It is to be remarked also that the first sound of the heart in such cases is often so abrupt as to lead the student to mistake it for the second sound.

The auricular-systolic murmur may merely precede the first sound—*i. e.*, it may originate in the pause of the heart's action, or it may be prolonged quite through the period of rest, being in this case necessarily associated with a degree of the ventricular-diastolic murmur presently to be described. (P. 578.) This last-mentioned condition is to be accounted for, according to Dr. Salter, on the supposition that the narrowing and roughening of the mitral orifice are so great that even the passive flow of blood from the auricle into the ventricle at the commencement of the diastole is sufficient to generate a "fluid vein."[1] In opposition to this view, however, Dr. Hilton Fagge argues that the auricle in extreme mitral stenosis begins to contract earlier, and goes on contracting longer, than in the healthy heart, and that the whole of the murmur is thus due to the auricular systole. This view seems to be established by the cardiographic tracings of Mahomed and Galabin. The varieties of the mitral obstructive murmur are represented in the diagram. (Fig. 108.) For the sake of brevity it is sometimes named "A.S." (auricular-systolic).

(2) *The murmur follows and runs off from the first sound*, ending somewhere between the first and the second, or close to the second sound. In this case the murmur is synchronous with the contraction of the ventricles, and may be called *ven-*

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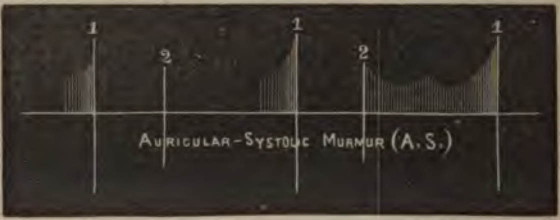
exactly expressed. (See Fig. 107.) The period of auricular systole has no definite place assigned to it in any scheme prior to Dr. Gairdner's; the old term "presystolic," as applied to a murmur, being vague, and giving no hint as to its coincidence with the systole of the auricle. The terms can be applied to all kinds of murmurs, indicating as they do simply the exact rhythm apart from any considerations of causation.

[1] A "fluid vein" ("veine fluide" of Savart), with its sonorous vibrations, is generated when blood passes with sufficient force into a part of the circulatory apparatus actually or relatively dilated. This explanation of the causation of murmurs was originally formulated by Corrigan, as far back as 1829, but of late years it has been put upon a more accurate scientific basis by M. Chauveau and other French observers. The theory is generally accepted as explanatory of arterial and venous murmurs, but some exception has been taken to its application to endocardial murmurs.

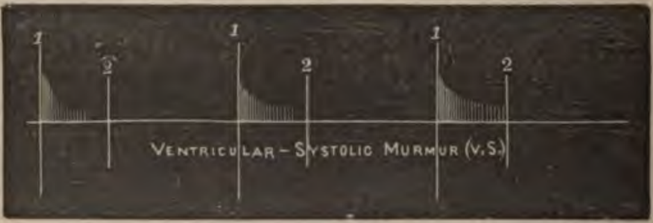
tricular-systolic. A ventricular-systolic murmur, being coincident with the emptying of the ventricles, must of course be caused (if valvular in origin) *by blood flowing from the ventricle,* either in the natural onward direction (over a roughened aortic orifice, for example), or backward, by regurgitation through the auriculo-ventricular orifices. When due to obstruction at the arterial orifices it is said to be a *direct* or *onward* murmur, but when caused by regurgitation through the auriculo-ventricular valves, it is named *indirect* or *backward.* It may be indicated diagrammatically, as in Fig. 109.

Fig. 108.



(Gairdner.)

Fig. 109.



(Gairdner.)

"V.S." is the contracted designation for this murmur (ventricular-systolic).

(3) *The murmur follows and runs off from the second sound,* ending somewhere during the interval between the second sound and the first. In this case the murmur is simultaneous with the dilatation of the ventricles, and may be called *ventricular-diastolic.* It may be represented as in Fig. 110. A

presystolic (from its preceding the systole of the ventricle). The interpretation of such a murmur depends on its *occurring only when blood is being expelled from an auricle,* and when the ventricle is still passive. With very rare exceptions such a murmur depends upon constriction of, or obstruction at, the auriculo-ventricular orifices, with consequent interruption to the flow of blood out of the auricle during its contraction. It is thus said to be a *direct* or *onward* murmur; it is usually very rough in character and often accompanied by a thrill. (See p. 569.) It is to be remarked also that the first sound of the heart in such cases is often so abrupt as to lead the student to mistake it for the second sound.

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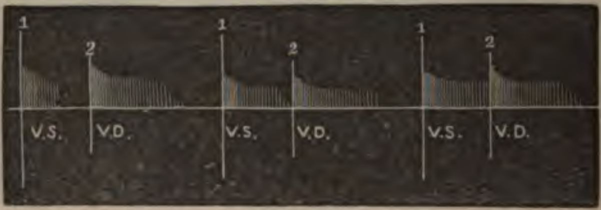
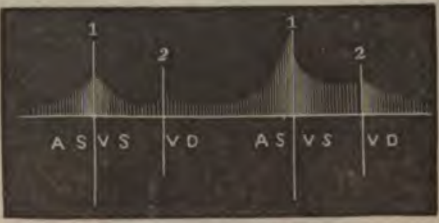
"*ventricular*-systolic." In like manner, a "*ventricular-systolic" and a "ventricular-diastolic*" (V.S. + V.D.) murmur are very frequently combined (in cases of aortic obstruction and regurgitation), but here the second sound intervenes and makes the rhythm quite plain. (See Fig. 112.) The greatest degree of difficulty arises when the sound is merged in the murmur, as it frequently is, when an "auricular-systolic" and a "ventricular-systolic" murmur are combined, but even in such a case it is often found that the first part of the murmur is very rough, and the second part has much more of a blowing character. The murmur will often, in fact, abruptly change its character about the moment of the apex-beat; or we may find that one element of the complex murmur is heard more clearly at the apex, and the other at the base, or elsewhere. A very complex association of murmurs is found when all the periods of the heart's movements are accompanied by murmur, extending even through the period of rest. This is represented in Fig. 113. (A.S. + V.S. + V.D.)

FIG. 112.



Ventricular-systolic and ventricular-diastolic murmurs combined. (Gairdner.)

FIG 113.



Auricular-systolic, ventricular-systolic, and ventricular-diastolic murmurs combined. (Gairdner.)

Various authorities (*e. g.*, Walshe, Hayden, etc.) have yet further differentiated murmurs as to their time or rhythm; and such terms as *postsystolic*, *prediastolic*, and *postdiastolic* are frequently to be met with. *Postsystolic* indicates that, the first sound remaining intact, the murmur occupies the portion of the short pause immediately following it. *Prediastolic* signifies that the murmur is heard during the latter part of the short pause, and runs up to and is closed by the second sound. *Postdiastolic* usually indicates what has been already described as an auricular-systolic murmur (see p. 576); but some authorities (*e. g.*, Hayden) attach a different signification to it, implying that it immediately succeeds an unchanged second sound, and is prolonged to a greater or less extent into the pause, terminating, however, distinctly before the occurrence of the first sound.

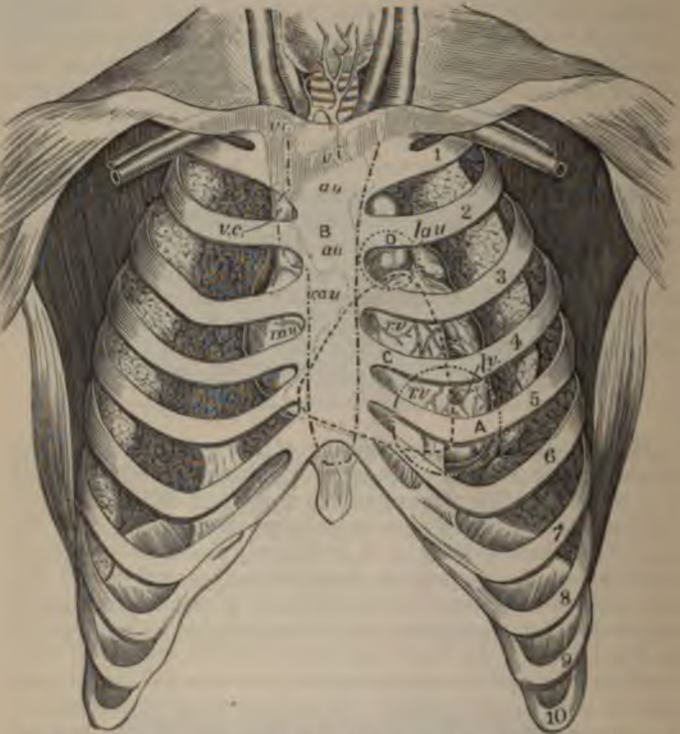
B. Area of Cardiac Murmurs.

Having determined the rhythm of a murmur, the next step in the investigation is to fix, within as narrow limits as possible, the place of its origin and the area of its diffusion.

The point at which a valvular murmur is produced being one of the four orifices, it is commonly desirable to test all murmurs on the supposition that they may be valvular. The first branch of the inquiry as to the seat of origin of a murmur is therefore commonly this: *At which of the four valvular orifices is it produced?* As there are four valvular orifices, so there are four distinctive areas to which murmurs arising at these orifices may be propagated. These have been determined by the accumulated experience of physicians at the bedside, checked by the results of post-mortem examinations. The following rules will be found useful in recognizing these areas.

(1) *Area of mitral murmurs.* The area of mitral murmurs corresponds generally with the apex of the left ventricle. To find this area with precision it is necessary to have determined all the points about the apex-beat insisted on in the earlier part of the physical examination. If a murmur concurs in position with the apex-beat, and if its area of diffusion is round this point nearly in a circle (see Fig. 114, area marked A); or even, and more especially, if the murmur is communicated more intensely and immediately to the left than to the right of the apex, as ascertained by the impulse, it is probably of mitral origin. This propagation to the left of the apex-beat is specially true of the regurgitant murmur, but the murmur

FIG. 114.



Areas of cardiac murmurs (Gairdner for the areas; and Luschka for the anatomy). The outlines of organs, which are partially invisible in the dissection, are indicated by very fine dotted lines; while the areas of propagation of valvular murmurs, as described in the text, have been roughly marked by additional much coarser and more visible dotted lines—the character of the dots being different in each of the four areas. A capital letter marks each area, viz., A, the circle of mitral murmurs, corresponding with the left apex; B, the irregular space indicating the ordinary limits of diffusion of aortic murmurs, corresponding mainly with the whole sternum, and extending into the neck along the course of the arteries; C, the broad and somewhat diffused area occupied by tricuspid murmurs, and corresponding generally with the right ventricle; D, the circumscribed circular area over which pulmonic murmurs are commonly heard loudest.

Reference letters:—r. au. = right auricle; a. o. = arch of aorta; v. i = the two innominate veins; v. c. = vena cava descendens; p. = pulmonary artery; l. au. = left auricle; l. v. = left ventricle; r. v. = right ventricle.

of mitral obstruction is often heard in its greatest intensity a little to the inner side of the apex impulse. Mitral murmurs are often heard over a very limited space in front of the thorax; they are mostly inaudible at the base of the heart; but, on the other hand, they are frequently conveyed with great distinctness to the back of the chest, about the lower angle of the left scapula. They are usually either "auricular-systolic" or "ventricular-systolic," the former being sometimes associated with a "ventricular-diastolic" portion; and various combinations of these occur.

Naunyn has asserted that the murmur of mitral regurgitation may have its seat of intensity, not in the apex region, as above described, but in the second interspace, an inch and a half or more to the left of the edge of the sternum, and that it is communicated to this point from the left auricle which crops up on the outer side of the pulmonary artery. He attributes this distribution of it to the better conduction of the murmur along the course of the regurgitating blood, and to the fact that, owing to its dilated condition, the left auricle, and especially its appendix, comes nearer to the surface. Paul Niemeyer, Gerhardt, and Dr. George Balfour concur in this opinion, but the question is still *sub judice.* Dr. George Balfour, who is the most strenuous advocate of this doctrine in this country, indicates that in anæmic and chlorotic conditions many of the so-called hæmic murmurs, referred to the area of the pulmonic valve, are in reality mitral regurgitant, and their seat of intensity is as described above. He accounts for them on the ground that "the defective nutrition of the cardiac muscle, depending on the depraved constitution of the blood, has resulted in relaxation of the muscular tissue, and dilatation of the ventricular cavity, this producing imperfect closure of the mitral valve, and hence a mitral murmur."

(2) *Area of pulmonic murmurs.* Murmurs in the pulmonary artery, or at the pulmonic valves, are carried to the ear nearly over the seat of the valves, or over the upper part of the right ventricle. The circle D in the diagram (Fig. 114), indicates the most elevated position of the murmur, but it is frequently heard more distinctly a little lower down. Its area coincides in position with that of the greatest distinctness of the pulmonic second sound as contradistinguished from the aortic second sound. Frequently it coincides in position with a certain tactile vibration or snap, as described above (see p. 566), accompanying the second sound. Pulmonic murmurs are usually very superficial, and therefore often very distinct, and apparently near the ear; they are nevertheless limited in their power of diffusion, being usually inaudible at the apex

and also along the sternum. They are never distinctly heard in the neck nor in the course of the great vessels. They are almost invariably "ventricular-systolic" in rhythm, but "ventricular-diastolic" murmurs may occur. Pulmonic murmurs are usually "functional" in character—*i. e.*, independent of organic disease of the valves; but it must not be forgotten that congenital malformations may exist at the orifice of the vessel, and may give rise to murmur. Even under such circumstances, the rhythm is usually systolic. (Compare also last paragraph.)

(3) *Area of tricuspid murmurs.* These murmurs are heard over the right ventricle where it is uncovered by the lung—*i. e.*, at the lower part of the sternum, and over the whole space between this and the seat of the mitral murmur. A tricuspid murmur is usually very distinct and superficial in its character, little audible, however, above the third rib, and thus distinguished both from the pulmonic, and still more from the aortic murmur. Its area in ordinary circumstances is indicated by the triangular space marked C. in Fig. 114, but in cases of considerable hypertrophy and dilatation of the right side of the heart, especially in connection with emphysema, the murmur is heard loudest toward the xiphoid and along the margin of the sixth or seventh left costal cartilage. The rhythm is usually "ventricular-systolic," but in rare instances it may be "auricular-systolic."

(4) *Area of aortic murmurs.* These murmurs are found not only in great intensity over the base of the heart and the manubrium sterni, which are so near their site of production, but frequently, and not less distinctly, along the whole line of the sternum; rather oftener than otherwise, the aortic regurgitant murmur (V.D.) is absolutely louder close to the xiphoid than at many points nearer to its origin. It is sometimes well transmitted to the apex region, and may even simulate a mitral obstructive murmur in rare instances. The aortic murmur is distinguished from all the other valvular murmurs by being propagated into the arteries of the neck. This is especially true of the obstructive murmur, which is usually transmitted with considerable intensity; the regurgitant, however, may be very faint and almost inaudible there. The aortic murmur has often a special distinctness over the sternal end of the second right costal cartilage ("aortic cartilage"). It is the most widely diffused of all the cardiac murmurs, and can sometimes be traced to great distances along the spine, and even into the extremities. The area marked B in Fig. 114

indicates the limits of distribution of the aortic murmur. The murmur may be "ventricular-systolic" or "ventricular-diastolic;" a combination of the two is very frequent.

Pericardial murmurs are usually present with both sounds of the heart, and when present with only one it is almost invariably the first. In certain cases pericardial friction may have a triple rhythm from the fact that roughening has occurred over the auricles as well as the ventricles; the first part of the murmur is presystolic, the second systolic, and the third diastolic. Pericardial murmurs are to be distinguished in part by their special acoustic character of friction, grating, creaking, or shuffling. In general terms they may be said to be deficient in precision of rhythm, and especially in what may be termed accentuation. They are liable to change both in rhythm and position from time to time. They are more considerably altered as to character and intensity by the position of the patient than endocardial murmurs, and they are also more considerably, and especially more essentially, altered in their character by pressure with the stethoscope. They are sometimes heard along the left margin of the heart or at the apex, but on the whole they most frequently occur over the right ventricle and at the mid-sternum, and are not carried into the arteries of the neck, or in the direction of the xiphoid cartilage. They are sometimes associated with well-marked fremitus (pericardial friction fremitus).

Pericardial murmur may be simulated by friction sound generated in the pleura at the borders of the heart. As a rule, this friction obeys the respiratory rhythm and ceases when the breath is held, but in some instances the friction, though due to roughening of the pleura, is developed by the cardiac movements. The distribution of the friction the absence of symptoms of cardiac derangement, and perhaps the presence elsewhere of signs of pleurisy, may guide the diagnosis.

Murmurs due to aneurisms of the arch of the aorta, especially of the ascending part, are with difficulty distinguished from those of aortic valvular disease. Sometimes the distinction is impossible, or can only be arrived at through the superadded signs of aneurism. Such murmurs are usually ventricular-systolic (V.S.) in rhythm, but a diastolic murmur may also occur in the aneurismal sac, apart from any valvular lesion.

Anæmic and functional murmurs (*so-called hæmic*), as heard over the heart and great vessels, are always ventricular-systolic (V.S.) in rhythm, and they almost always simulate aortic or pulmonic murmurs as regards their area. In rarer instances, however, they may be confined to the apex region. They are to be distinguished from murmurs of organic origin chiefly by the circumstances in which they occur, and by the absence of symptoms of valvular disease.

A metallic echo of one or both cardiac sounds may simulate a murmur and may be produced in an air-filled cavity in the neighborhood of the heart (tubercular cavity in the lung, pneumothorax, and distended stomach). It is distinguished by its peculiar, hollow, ringing, or booming quality. Reduplication of a sound is apt in some cases to simulate a murmur, especially when the reduplication is incomplete, but attention to details will minimize this difficulty.

Murmurs in the arteries. In almost all the large arterial trunks a murmur, ventricular-systolic (V.S.[1]) in rhythm, may be evoked by pressure with the stethoscope. Apart from this pressure, however, such a murmur is often present in the subclavian arteries, more especially on the left side, and that without any lesion at the aortic orifice. It may be present in anæmic conditions, but is not uncommon in apparently healthy subjects. If, however, there is a double murmur (V.S. and V.D.) in the aortic area, the systolic portion is invariably carried into the vessels of the neck with considerable intensity, and in not a few instances the diastolic is propagated in a similar direction, though very faintly. Murmurs are very frequently present at the root of the pulmonary artery (see p. 583), and may exist also in aneurismal affections of the aorta. Duroziez pointed out that in certain diseased conditions, especially in aortic insufficiency, pressure with the stethoscope educed not only a systolic but also a diastolic murmur in the arteries, chiefly in the femorals, but it has also been found apart from any disease of the vascular apparatus.

Murmurs in the veins may also be present, especially in the large trunks at the root of the neck. They are loudest, as a rule, on the right side. They are humming or musical in quality, and are continuous; they are thus easily differ-

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[1] Strictly speaking, and with reference to absolute accuracy indeed, the rhythm of an arterial murmur cannot be indicated in terms of cardiac derivation at all; the exact time of the arterial murmur *produced* by the contraction of the ventricles, and the onward current in the vessels being by so much *later* than the ventricular systole, as the vessel is remote from the heart. A more strictly accurate nomenclature, therefore, would be to call an arterial murmur, such as is here indicated, *arterial-diastolic*—*i. e.*, coincident in time with the expansion, diastole, or pulse of the individual artery examined. In some cases the postponement of the arterial murmur to the cardiac impulse is easily verified, and the above term is not only apposite and convenient, but of practical importance.

TABULAR VIEW OF CARDIAC MURMURS OF VALVULAR ORIGIN.

A. Determine the rhythm of the murmur. B. Determine its site or the area of its distribution.

Rhythm of murmur.	The various causes of a murmur having such a rhythm.	Diagnosis from rhythm area combined.
Before first sound or auricular-systolic (A.-S.).	Obstruction at the (1) right or (2) left auriculo-ventricular orifice.	If in *mitral* area = obstruction at mitral orifice. If in *tricuspid* area = obstruction at tricuspid orifice (very rare).
After first sound or ventricular-systolic (V -S.)	Obstruction (1) at the orifice of the aorta, or (2) the orifice of the pulmonary artery. Regurgitation (3) through mitral orifice, or (4) through tricuspid orifice.	If in *aortic* area = obstruction at aortic orifice. If in *pulmonic* area = obstruction at orifice of pulmonary artery (very rare). If in *mitral* area = mitral regurgitation. If in *tricuspid* area = tricuspid regurgitation.
After second sound or ventricular-diastolic (V.-D.).	Regurgitation (1) through aortic semilunar valves, or (2) through semilunar valves of pulmonary artery.	If in *aortic* area = aortic regurgitation. If in *pulmonic* area = regurgitation through valves of pulmonary artery (very rare).
After second sound and running up to first (V.-D. + A.-S.).	(1) obstruction at auriculo-ventricular orifices in an extreme form.	If in *mitral* area = obstruction of mitral orifice. If in *tricuspid* area = obstruction at tricuspid orifice.
	(2), or, if complex, a *combination* of obstruction at one or other auriculo-ventricular orifice (A.-S. element), and regurgitation through the aortic or pulmonic valves (V.-D. element).	If the *two elements of the murmur have separate areas—e. g., mitral* and *aortic*—this indicates mitral obstruction combined with aortic regurgitation.

entiated from arterial murmurs in the same locality, which intermit with the cardiac action. This *venous hum* (humming-top sound or *Bruit de diable*) is often associated with impoverished states of the blood (anæmia, chlorosis, etc.), but does not necessarily indicate organic disease. The position of the patient is apt to influence both the intensity and quality of these murmurs, the erect posture generally rendering them louder and more musical; inspiration has a similar effect.

THORACIC ANEURISM.

Incidental allusions have been made in the preceding pages to aneurism of the thoracic aorta and its branches, but it may be well to indicate a little more in detail points to which attention should be given in the investigation of this subject. The position of an aneurism will vary according to the portion of the vessel involved. It may impinge on the thoracic wall in the immediate neighborhood of the heart, or at almost any point in the thorax; and aneurisms of the innominate branch of the aorta may even reach high up into the neck. A very frequent seat of thoracic aneurism is under the manubrium sterni. Aneurisms of the ascending arch are said to pass chiefly to the right of the sternum, those of the transverse arch lie, as a rule, under the manubrium, while those of the descending arch tend to the left side. No fixed rules can be laid down, however; in some instances the pressure signs and symptoms may aid us in determining the portion involved.

Aneurism in the thorax often causes a local *bulging of the chest wall*, and when looked at in a cross light this bulging may be seen to pulsate, while palpation at once detects the heaving action. If the aneurism has by its pressure eroded any portion of the bony structure it may present itself as a distinct *pulsating tumor*, the impulse being separable from that of the heart, both by position and rhythm (the cardiac impulse immediately preceding that of the aneurism), and if the tumor is grasped at its periphery between the fingers, the *pulsation is found to be expansile or eccentric;* and this is a very valuable diagnostic point from glandular tumors, cancerous growths, abscesses, etc., in the mediastinum, which may simulate aneurism by having the heave of the aorta communicated to them. Occasionally the aneurism may yield a double impulse, corresponding with the cardiac systole and diastole; the latter, or "impulse of arrest," as it is sometimes called, being generally slight when present at all. A distinct *thrill* is also occasionally felt; most frequently in aneurisms near the heart. Along with these signs there may be an *area of dull percussion*, which, according to the size and position of the aneurism, may be separable from the cardiac dulness, joined to it by a more or less narrow neck, or quite continuous with it.

In many instances, however, no distinct pulsating tumor is present, although there may be an obscure heave, and the only definite physical signs are an area of percussion-dulness, more or less marked, in the track of the aorta, and certain auscultatory phenomena to be mentioned immediately. Sometimes, indeed, even these signs are wanting or very obscure, and the diagnosis may rest almost entirely on other signs and symptoms, such as fixed pain, dysphagia, dyspnœa, laryngeal paralysis, hæmoptysis, signs of pressure on nerves and veins, displacements of the trachea, backward or to either side, sense of fulness in the jugular fossa, changes in the pupils, pulses, etc. (Compare also Chapter IX.)

The *auscultatory signs* may vary. In some instances, especially where the tumor involves the first part of the ascending arch, murmurs following both sounds (V. S. and V. D.) may be present, owing to implication of the aortic valves. But independently of any such condition, murmurs may be found in aneurisms in any part of the thorax, the rhythm being usually "ventricular-systolic," or, more correctly, arterial-diastolic, as it corresponds with the expansion of the artery. In many instances, however, no murmur is present, but the cardiac sounds as heard over the suspected area may have undergone alteration. Both sounds may have become very distinct, sometimes even more so than over the cardiac region; the second is especially apt to be accentuated, and even to develop a different quality, becoming deepened in tone or "booming," and this character is transmitted into the vessels of the neck. This mere change in the second sound would not warrant any diagnosis of aneurism, as there are other conditions which induce it. In the aneurismal conditions it is sometimes wanting, but when present with symptoms such as are indicated above, and accompanied by an area of dull percussion in the line of the aorta, the preusmption of aneurism becomes very strong.

Simple dilatation of the arch of the aorta may give rise to varying degrees of percussion-dulness, chiefly in the region of the manubrium sterni. There is, as a rule, no visible or tangible impulse over this area; but if the finger is inserted into the jugular fossa, the dilated vessel may be easily felt, and its impulse recognized. The second sound is usually accentuated and booming, but pressure symptoms are, as a rule, absent.

Signs of aneurism may present themselves in the back of the thorax. Percussion-dulness of limited area, and close to the left side of the spine, with changes in the cardiac sounds and symptoms of pressure, as already indicated, have to be chiefly relied on. Indeed, in many such cases physical examination may yield little information, and the diagnosis will depend almost entirely on the other symptoms.

The conditions most likely to simulate aneurism are visible and tangible pulsation from the pulmonary artery or left auricle, about the second left intercostal space (for diagnosis see p. 566); pulsating empyema and cancerous tumors. Pulsating empyema usually occupies the normal situation of the heart, which is found displaced to the right, and communicates its impulse to the fluid collection. There is, as a rule, a distinct history of a pleuritic attack, and it is unattended by murmur, thrill, or alteration in the cardiac sounds. Pulsating cancer may present more difficulty, as it may be attended by murmur, and give rise to all the pressure symptoms already indicated. But careful palpation may detect that the pulsation is not so distinctly expansile as in aneurism, nor does the centre of pulsation correspond to that of dulness. The glands in the neighborhood that are accessible may be discovered enlarged, the cachexia may be well marked, and the sounds of the heart over the dull area, except in so far as attended by murmur, do not present the alterations so often found in aneurismal conditions.

PULSE[1]—SPHYGMOGRAPH.

The sphygmograph is an instrument designed to enable the pulse to register itself, and so afford a permanent record of *its frequency, its regularity, its force, and, above all, of the characters of the pulse wave.*

Many forms of the instrument are now in use, but they are all constructed upon the principle of Marey's sphygmograph; the essential parts being a spring which rests upon the artery, and vibrates with its movements, and a lever to which these movements are transmitted, and which records them in an amplified degree on a slip of paper carried along by clockwork. The sphygmographs chiefly in use in this country are those of Marey, modified by Mahomed, of Dudgeon, and of Pond.

Marey's sphygmograph (Fig. 115) consists of a brass framework

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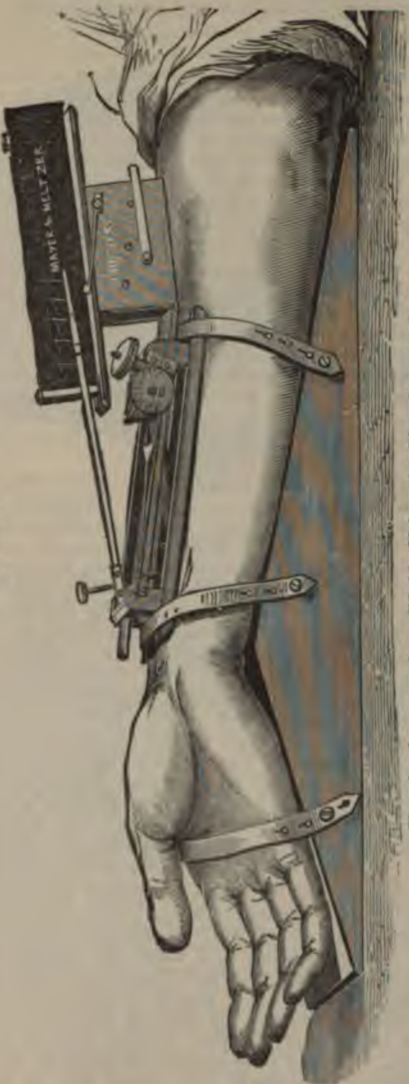
[1] Compare also section on the "Pulse," at p. 98.

FIG. 115.



Marey's sphygmograph, modified by Mahomed, with wrist-rest and straps.

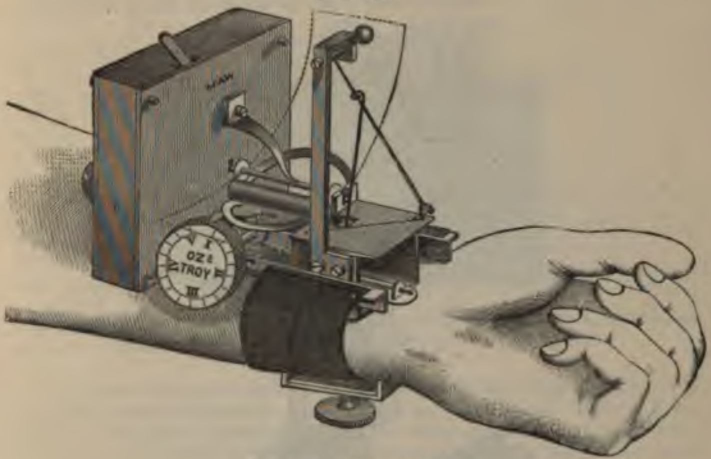
fitted with a steel spring, which rests upon the artery and communicates its pulsations to the long lever (made of light wood and terminating in a style), which records them vertically upon a strip of blackened paper or mica, carried along at a given rate—about four inches in ten seconds—by the clockwork frame into which it is fitted. Mahomed effected a most important improvement in Marey's instrument by adapting to it means for the regulation of the pressure of the spring upon the artery. This consists of an "eccentric," by depression of which a definite degree of pressure can be brought to bear, and the dial indicates the amount, from one to eighteen ounces troy, which is applied. In order to give steadiness to the hand and arm, as well as to afford means for fixing the instrument in position, a wrist-rest or cushion is used, as indicated in the illustration.

The artery, for which Marey's instrument is specially adapted, is the radial, and the point at which it is most advantageously applied is just where the artery crosses the styloid process of the radius. The advantages are that the vessel is here very superficial, and is supported on a firm flat surface. If possible, the patient should be in the recumbent posture, as this generally assures the most tranquil state of the circulation; and great care should be taken that the humeral artery is subject to no pressure in any part of its course. The instrument may also be applied while the patient is in the sitting posture, his arm resting on a table in front of him.

The point where the radial artery is most salient should be carefully sought for and marked with ink or pencil. The patient's wrist is then laid in the "rest," and the button which the sphygmographic spring carries at its free extremity is placed immediately over the artery. The straps, which should be inelastic, are then fastened to retain the instrument in its place, the fingers being held in a semi-flexed position. If the spring is not accurately adjusted over the artery it may be shifted about a little without undoing the fixings, but generally it is preferable to apply the sphygmograph afresh. After the spring is in position it is connected with the lever to see that it is working properly before any attempt is made to register the tracing on paper. The spring must be fairly placed on the artery, as the least deviation to the side may deform the tracing, and render it not only worthless, but absolutely misleading. The pressure also must be carefully regulated, a number of tracings with varying degrees of pressure being taken, and the most perfect selected. The slips on which the tracings are taken may be prepared in various ways. One of the most effective is to pass them through the smoke of a camphor flame till they are sufficiently coated to allow of the style or needle leaving its impress. The smoke of a turpentine flame, or even of a candle, may also be used. If the paper is too deeply smoked it is apt to retard the excursion of the needle and so deform the tracing. The paper employed should have a high glaze; and after the tracings are taken the patient's name, with the date and the pressure employed, may be marked on them by means of a needle or other sharp point. They are then rendered permanent by dipping them into photographers' varnish, or a solution of one part of gum benzoin in five parts of rectified spirits. Smoked mica may be used instead of paper; and in the case of Marey's instrument the tracing may be taken with ink, but the method detailed gives more delicate results.

Dudgeon's sphygmograph (Fig. 116) is a very handy instrument. It is much cheaper than the other varieties; and as it requires no wrist-rest, and is small and easily portable, it is capable of more extended use in practice than Marey's. It is especially designed for adaptation to the radial. The needle writes upon the horizontal, and pressure, ranging from one to five ounces, is applied by means of an "eccentric."

Fig. 116.



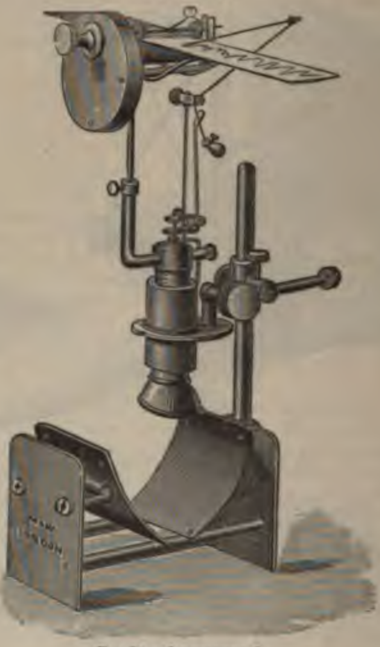
Dudgeon's sphygmograph.

Pond's sphygmograph (Fig. 117), which can also be employed as a cardiograph, is very easily adjusted and capable of wider application to the circulatory system than the instruments already mentioned. The pulsations of the artery are in it communicated through an India-rubber diaphragm (or, in the latest modification, through a metal button attached to a spiral spring), to a series of levers, terminating in a needle, which writes upon the paper on the horizontal. The instrument is attached to a frame into which the wrist may be laid, but can be easily detached from this and applied by the hand, to almost any superficial artery in the body. The pressure gauge is fitted on the upright stem of the instrument, but cannot be regulated with any degree of nicety.

In the hands of a capable observer all the instruments above described give reliable results, and the tracings with which the text is illustrated are selected from a series afforded by all three. Various forms of "transmitting sphygmographs" have been devised, and they are of special use in cases where simultaneous tracings of the pulse, the cardiac apex-beat, and it may be the respiration are desired; but, on the whole, the "polygraph" of Marey is the most satisfactory.

Events in a Normal Sphygmogram.—Each individual pulse wave in a sphygmogram is made up of a series of "events" to which special names have been applied. Ths following may be taken as a reminder of the more special points in relation to these various phenomena, but the student will do well to consult recent physiological works for fuller details.

FIG. 117.



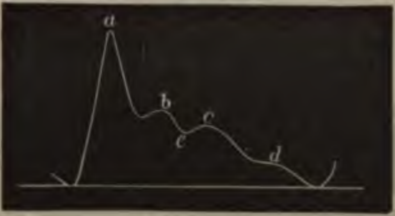
Pond's sphygmograph.

The line from which the tracing starts is called the "*respiratory*" or "*base line*," as it represents the point of residual tension in the vessel. On the ventricular contraction taking place the sphygmographic lever describes an ascent, more or less perpendicular, named the "*primary or percussion wave*," terminating in an apex (Fig. 118, *a*) more or less acute. Then follows a slight descent, succeeded by the "*secondary*," "*tidal*," *or* "*predicrotic*" *wave* (Fig. 118, *b*), which is supposed to indicate the true blood wave in the vessel.[1] The notch (Fig. 118, *c*) which succeeds the tidal wave is designated the "*aortic*" *or* "*dicrotic*

[1] The separation of the primary and tidal waves is by some believed to be, in many instances, at least, due to the inertia of the lever of the sphygmograph, the velocity which it acquires on the sudden ventricular contraction carrying it a little too far, and so leading to the separation of the two waves. This may be so when the primary wave is ample, the ventricle delivering its charge sharply and suddenly, but there are many instances where reverse conditions obtain, and yet the two waves are perfectly distinct.

notch," and is coincident with the closure of the sigmoid valves, indicating the termination of the ventricular systole. Then follows the "*dicrotic wave*" (Fig. 118, *c*), caused, for the most part, at least, by the recoil of the blood from the root of the aorta. The descent line, broken it may be by one or more small waves (Fig. 118, *d*), then falls gradually to the base line of the next pulsation.

FIG. 118.



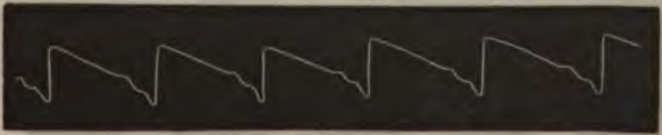
"Events" in a normal sphygmogram: *a*, primary or percussion wave; *b*, secondary or tidal wave; *e*. aortic notch; *c*, dicrotic wave; *d*, fourth wave.

In a good tracing the apex is usually more or less pointed. Rounded apices are to be regarded with distrust, as indicative of faulty adjustment or incorrect pressure. In certain instances, however, as in well-marked aortic stenosis (Fig. 134), a rounded apex is one of the most distinctive features of the tracing.

The various events indicated in diagram in Fig. 118 are easily recognizable in most healthy pulse tracings—*e. g.*, Fig. 119, in which is registered, under three ounces pressure, a healthy pulse numbering 68.

A pulse of this character giving an unbroken ascent line is called "*katacrotic;*" but when the summit of the tracing is reached through an ascent line broken by one or more shoulders or peaks (Fig. 120, *a a*), the pulse is said to be "*anacrotic.*"

FIG. 119.

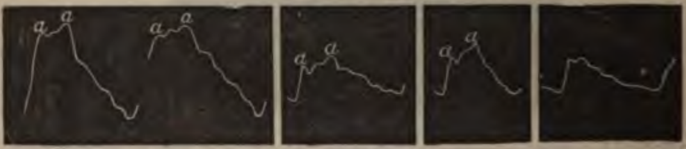


Healthy pulse. Pressure, 3 oz. Pulse, 68.

In katacrotic tracings the distention of the artery is accomplished so suddenly that it is equal to one elastic vibration, and the ascent line is therefore unbroken; but when the distention is effected more slowly then the maximum pressure in the pulse wave occurs toward the end of the ventricular systole, and the upstroke is broken by a more or less well-defined notch—it is anacrotic. Anything which affords an obstacle to the discharge of the blood from the ventricle may produce this form of pulse. Hence it is seen in well-marked aortic stenosis (Fig. 134); in cases where the arterial tension is very high; or where the vessels are atheromatous.

The characters of the pulse tracing, however, will depend greatly upon the pressure exerted upon the artery, and the utmost care is therefore necessary in its regulation. As Mahomed truly observes, "the use of incorrect pressure is perhaps the most common source of error in sphygmography." A series of tracings should be made with varying degrees of pressure, and those in which the individual events are most distinctly indicated selected for preservation. Observation should be made in each case, also, as to the amount of pressure requisite to obliterate the pulse. In cases where the vessels are not atheromatous this gives valuable information as to the energy of the cardiac contraction, and the tension resident in the vessel.

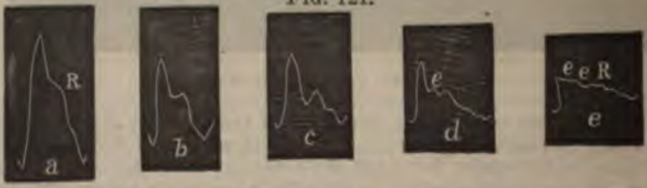
FIG. 120.



"Anacrotic" pulse curves, from the radial artery: *a*, *a*, the anacrotic notches. (Landois.)

The changes in the form and relation of the individual parts of the pulse curve under varying pressure are well illustrated by the series of radial tracings in Fig. 121. When the pressure is small the dicrotic wave is relatively less; the whole curve high. (Fig. 121, *a*.) With a moderate pressure (*b*, 100, c. 200 grammes) the dicrotic wave is best marked; the whole pulse wave somewhat lowered. On increasing the pressure (*d*, 250, *e*, 450 grammes) the dicrotic wave diminishes, the tracing loses in height, the time occupied by the ascent becomes shorter, while the descent line lengthens. It is only when pressure from 220 to 300 grammes is exercised that the vibrations (*e e*) preceding the dicrotic wave appear. This will serve to show what an important element pressure is, and how carefully it should be adjusted.

FIG. 121.



Various forms of radial pulse curves obtained by gradually increasing the pressure (*a*, *b*, *c*, *d*, *e*): *e e*, predicrotic waves: *R*, dicrotic wave. (Landois.)

Arterial Tension.—The sphygmograph gives valuable evidence as to the degree of tension in the arterial system; indeed, the indications afforded by it in respect of this, are among the most useful and reliable in sphygmography.

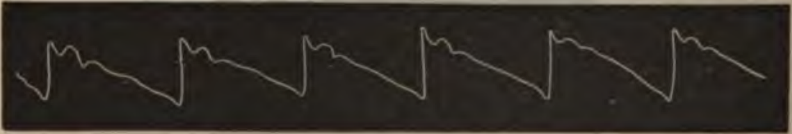
In robust health the tension in the pulse may be very considerable (see Fig. 119), but in certain morbid states it is apt to be much augmented; the blood pressure in the artery is abnormally great; there is what is termed *high tension*. Pulses of high tension may to the finger be large or small—large, when with impeded capillary outflow the blood is discharged into the arteries by a powerful ventricle; small, when the muscular coat of the vessels is in a state of tonic contraction. In both instances the pulse wave is hard to obliterate by the finger; but in the one case it is large and full, in the other small and wiry. In the latter instance the pulse to the finger of a careless or inexperienced observer may give a very deceptive impression.

The graphic characters which indicate high tension are: (*a*) *Prominence and sustension of the tidal wave;* (*b*) *smallness of the dicrotic wave;* (*c*) *occurrence of the dicrotic wave high up in the diastolic line*, which sinks gradually to the next upstroke. We may add to these that the pressure requires to be considerable to obtain a good tracing.

Prominence of the tidal wave is a very valuable gauge of high tension when the vessels are not atheromatous. Indeed, when in a pulse tracing any part of the tidal wave rises above a line drawn from the apex to the aortic notch it indicates, as a rule, undue blood pressure. It will not do, however, to rely upon this character of the tidal wave alone. Other indications must corroborate it. This character of high tension is due to difficulty of arterial outflow. The systole of the ventricle is, therefore, prolonged, and what is believed to be the true ventricular wave, viz., the tidal, is ample and sustained.

Such a form of tracing is well seen in Bright's disease, especially the chronic form with cirrhotic kidney; but it is often enough apparent in acute and subacute attacks. (Fig. 122.) Indeed, it has been described by Mahomed as a condition antecedent even to the establishment of albuminuria. In angina pectoris it is of the utmost consequence to determine whether, during the attack, the arterial tension is high, as it gives the key to the treatment.

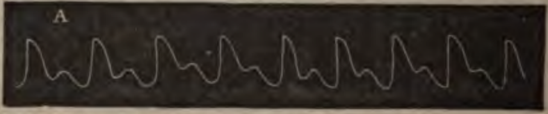
FIG. 122.



Pulse tracing from a subacute case of Bright's disease in a boy aged ten. Pulse, 56. Pressure, 5 oz.

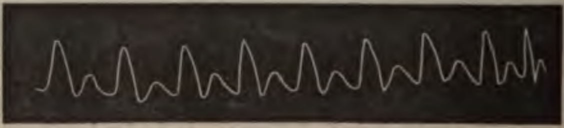
Dicrotism.—In the febrile state, and in other conditions, as after hemorrhage, where the arterial tension is low, the elasticity of the vessels unimpaired, and the ventricular contractions short and sharp, there is developed what is termed the "dicrotic" pulse; a fact often enough appreciable by the finger. In it *the tidal wave is no longer apparent* (the maximum blood pressure occurring early in the ventricular systole), *the aortic notch is lowered, and the dicrotic wave much increased.* Various degrees of dicrotism are recognized. A pulse is "dicrotous" when, with a very marked secondary wave, the aortic notch does not reach the respiratory line. (Fig. 123.)

FIG. 123.



Dicrotous pulse. Pressure, 2½ oz. Pulse rate, 110. From a patient aged twenty-four, suffering from phthisis.

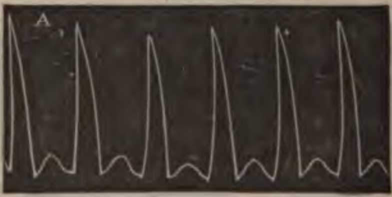
FIG. 124.



Full dicrotism. Pressure, 1¾ oz. Pulse, 112.

It is said to exhibit "full dicrotism" when the aortic notch reaches the level of the respiratory line. (Figs. 124, 125.)

FIG. 125.



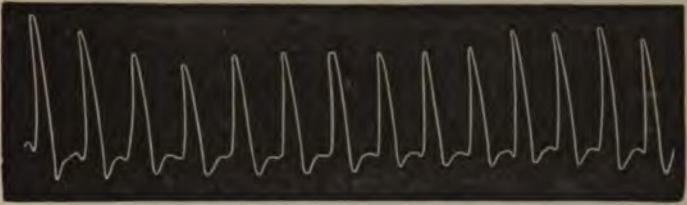
Full dicrotism. Pressure, 1 oz. Pulse rate, 110. From a case of acute rheumatism.

When the aortic notch falls below the respiratory line, the term "hyper-dicrotous" is employed. (Figs. 126, 127.)

It will be apparent that the hyper-dicrotous character results from the dicrotic wave being caught up, before it has spent itself, by the next cardiac contraction; and should the pulse, under such circumstances, become very rapid, the dicrotic wave may be lost entirely, and the pulse become "monocrotic." (Fig. 128.)

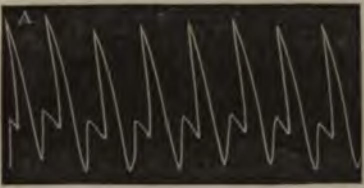
Dicrotism is indicative of low tension, and its characters are best developed under low pressure. It may be produced by slight causes in persons of nervous temperament, but it is in febrile diseases that it attains its most typical characters; and the degree of dicrotism may aid in the estimate of the gravity of a case, inasmuch as it affords a key not only to the character of the cardiac action, but also to the tone of the nervous system generally. It is thus also an important guide for stimulation. The conditions which favor the production of dicrotism are, sudden and sharp ventricular contraction, elasticity of the vessels, low arterial tension, and free capillary outflow.

FIG. 126.



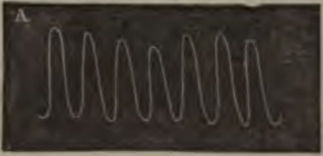
Hyper-dicrotous pulse. Pressure, 2 oz. Pulse, 120.

FIG. 127.



Hyper-dicrotous pulse. Pressure, 1¾ oz. Pulse rate, 130.

FIG. 128.

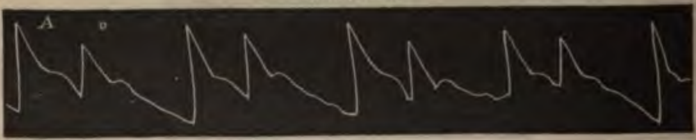


Monocrotic pulse. (After Riegel.)

Intermittence and Irregularity of the Pulse.—The sphygmograph gives ready indication of any irregularities either in rhythm or volume of the pulse waves. It occasionally happens that without any alteration in time every second pulse wave lacks volume. This is the condition described by Traube as "*pulsus alternans.*" In other cases the pulse is "*intermittent,*" the heart now and again enjoying a longer repose than usual, and hence the regularity of the tracing is disturbed. It is to be noted in such cases that the pulse wave following the pause is invariably more ample. This form of intermission, which may be regular or irregular in time, is not inconsistent with health, or, at least, may depend upon temporary conditions, such as indigestion, or excessive tobacco smoking. It is to be carefully distinguished from a form of "false" intermission where the ventricular contraction fails to reach the wrist, or is too feeble even to raise the aortic valves; or where a fatty and dilated ventricle relieves itself through a patent mitral orifice. The systole in such cases is abortive, and has no arterial expression, a fact of the utmost significance as indicative of degenerative changes in the cardiac muscle. In every case of pulse intermission, therefore, the pulse rate should be critically checked by auscultation over the heart.

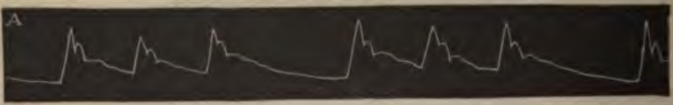
In some instances, the irregularities conform to certain types. They may occur at fixed intervals, as, for instance, every two or three beats. Illustrations of this are found in the "*pulsus bigeminus*" (Fig. 129 and Fig. 131, Nos. 3, 5, 6), in which the pulse waves run in pairs, and in the "*pulsus trigeminus*" (Fig. 130), in which they run in groups of three.

FIG. 129.



"Pulsus bigeminus;" convalescent from pneumonia. Pulse, 68; pressure, 2 oz.

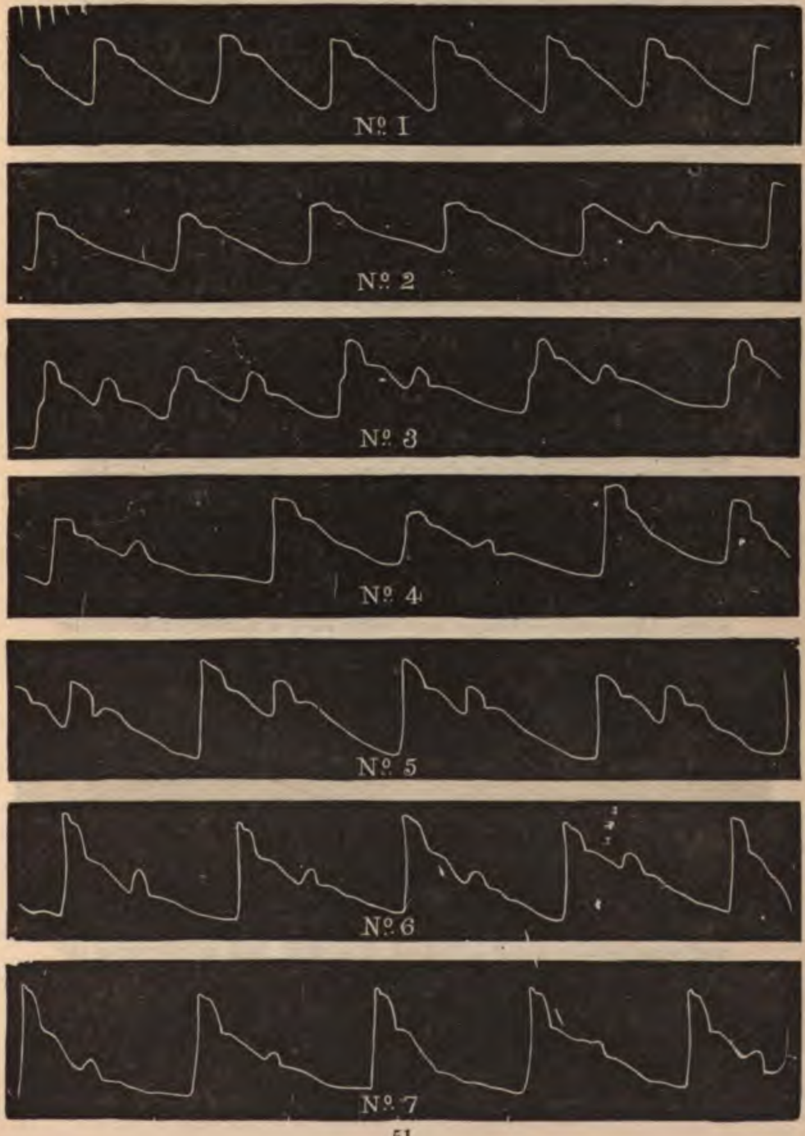
FIG. 130.



"Pulsus trigeminus," J. B., aged sixty-five. Typical angina pectoris without apparent valvular or aneurismal disease; pressure, 3 oz. Died suddenly.

Various forms of irregularity, both of rhythm and volume, are illustrated in the series of tracings in Fig. 131, and it is to be remarked in connection with this series, that the sphygmograph will detect pulse waves inappreciable by the finger. In Nos. 6 and 7 it was found that every second cardiac beat failed to reach the finger at the wrist, but the sphygmograph reveals them clearly as distinct interruptions in the long descent line.

Fig 131.



Pulse tracings from a man, aged sixty, suffering from bronchitis; no cardiac complaint, and no physical signs of valvular mischief or hypertrophy of the heart (Gairdner, *Glasgow Medical Journal*, vol. iv. p. 548.)

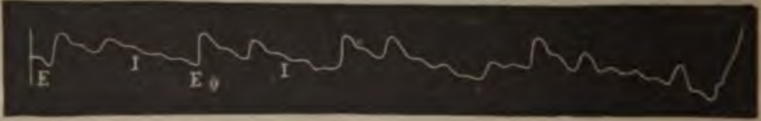
The sphygmographic observations extended over a fortnight. In the morning, for minutes together, the pulse was often perfectly regular, then two or three irregular beats occurred, and the regular rhythm again resumed. As the day advanced the irregularity usually became greater. A study of the tracings affords means of observing the regular gradation from the strictly normal pulse down to that in which the alternate feeble beats are hardly appreciable, only the strong ones being distinctly rendered on the paper. No. 1 gives the regular pulse, numbering 72 Nos. 2, 3, and 4 give various degrees of irregularity. No. 5 shows the most marked form of the rhythmic irregularity (pulsus bigeminus), the feeble beats being quite marked and the dicrotism after each quite appreciable. In No. 6 the alternate feeble beats are less strongly marked, and in No. 7 they might be mistaken for the dicrotism of a normal pulse. The rate of pulsation, in all cases when the rhythmic irregularity was so well developed as to be practically constant over a minute or so, was about 40 when numbered at the wrist by the strong pulses only, and 70 to 80 when numbered according to the cardiac pulses.

Respiration sometimes materially modifies the pulse tracing. This may be apparent even in healthy subjects, the tension falling during inspiration and rising during expiration. (Fig. 21.) When the breathing is deep and stertorous, as in apoplexy or uræmic coma, the undulatory character of the respiratory line of the tracing may be well marked. (Fig. 22.)

In exceptional cases during inspiration the pulse wave may be almost totally suppressed, the "*pulsus paradoxus*" of Kussmaul (Fig. 132), a condition attributable to the compression of the great vessels by fibrous bands passing between them and the thoracic wall, and these of course are put upon the stretch during the inspiratory act. It has been observed, however, under other conditions.

Senile Pulse.—A very characteristic form of tracing is found in cases where degenerative changes have occurred to a marked extent in the arterial walls. It is spoken of as the "senile pulse," as the conditions which give rise to it—*e. g.*, atheroma and calcareous degeneration, are common in later life. The tracing is, as a rule, ample, the tidal wave well sustained—so much so, indeed, in certain cases as to overtop the apex of the upstroke and afford an anacrotic tracing, and the dicrotic wave is little marked. (Fig. 133.) The degree to which these characters are developed will, of course, depend to a large extent upon the amount of rigidity and the consequent loss of elasticity. Low pressure, as a rule, gives the most typical tracing, although the pressure requisite

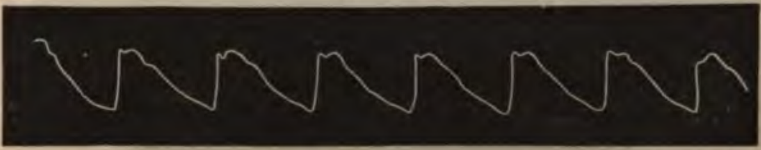
FIG. 132.



"Pulsus paradoxus" (after Kussmaul). I, inspiration; E, expiration.

to obliterate the pulse is great, owing to the condition of the vessel walls. In certain instances, however, it may be a pulse of high tension.

FIG. 133.

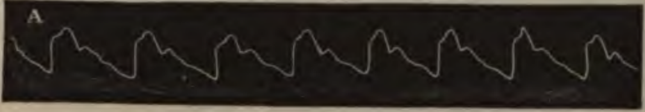


Senile pulse. Patient aged seventy-two; arteries very rigid; considerable hypertrophy of left ventricle.

The sphygmograph gives characteristic tracings in certain well-marked forms of cardiac valve disease, especially in cases where the left ventricle is affected.

Aortic stenosis, pure and simple, is a comparatively rare condition, but when well marked it gives a highly distinctive tracing. (Fig. 134.)

FIG. 134.

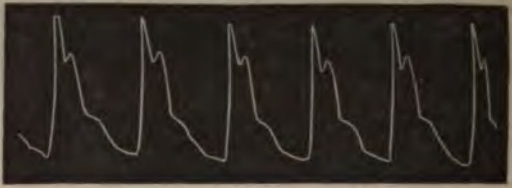


Aortic stenosis in a patient aged twenty-six. Pressure, $5\frac{1}{8}$ oz. Loud, rough systolic murmur at aortic cartilage; pulse small but hard; evidences of moderate ventricular hypertrophy.

Here, owing to the obstruction at the root of the vessel, the primary wave is impeded, and as the ventricle discharges its contents slowly and deliberately the tidal wave is well sustained, overtops the primary wave, and forms the rounded summit of the tracing. The pulse, in fact, is anacrotic. In cases of extreme obstruction there may be no differentiation of the primary and tidal waves, the two being fused into a simple undulation. The degree to which the tidal wave is produced may be taken as a gauge of the amount of obstruction; and in cases where there is regurgitation associated with the obstruction, in the absence of atheromatous conditions, the degree to which the tidal wave is developed may be regarded as significant, to some extent, of the amount of obstruction present.

Aortic regurgitation affords a striking contrast to the preceding tracing. The pulse wave in this lesion is usually very ample, the primary wave vertical, well produced, and terminating in a sharp apex, while in the diastolic part the aortic notch is low and the dicrotic wave small, at least relatively so. The characters of the systolic part of the tracing indicate that a powerful ventricle is discharging a large quantity of blood into vessels in a state of low tension. Such characters are often met with in functional disturbances of the heart in nervous people, so that they are by no means characteristic of aortic incompetency. But the diastolic part of the tracing is very significant. No sooner is the cardiac systole past than the blood tension falls suddenly from the regurgitation through the patent orifice, and hence the collapsing character of the tracing, and the diminution and low position of the dicrotic wave, which, under normal conditions, is the expression of the recoil of the blood column from the aortic valves. In cases where atheroma exists the tidal wave, as in Fig. 135, may be very apparent; in some instances, indeed, the primary and tidal waves form twin peaks. Even in the absence of atheroma, should considerable obstruction be associated with the regurgitation, the tidal wave may be well developed, as the ventricle discharges its contents more slowly; but even apart from obstruction, temporary high tension from the large quantity of blood thrown into the vessel may give a well-sustained tidal wave.

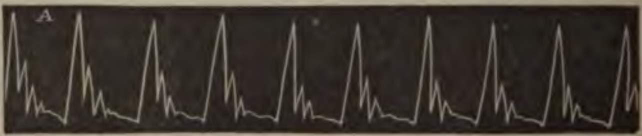
FIG. 135.



Pulse of aortic regurgitation. Pressure, 2¾ oz.

Fig. 136 indicates the characters of very free regurgitation in a young subject. The aortic notch is as low as the base line, the dicrotic wave is very small, and the tracing thereafter very flat. It was developed under low pressure, and when the pressure was increased the dicrotism disappeared. Some approximation may be made to the amount of regurgitation present by considering the degree to which these characters are developed.

FIG. 136.



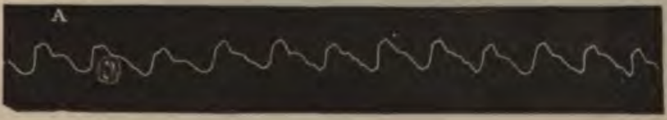
Pulse of aortic regurgitation. Pressure, 2 oz

Capillary Pulse.—This seems to be the most fitting place to refer to the capillary pulse, inasmuch as it is brought about by aortic incompetency. It consists in the fact that pulse waves can be seen in the superficial capillary vessels. It can be well demonstrated by rubbing the skin, say of the forehead, with the finger so as to produce a capillary blush, which may be seen to flush and pale with the systole and diastole of the heart. In certain rare instances the pulse waves are transmitted quite through the capillaries into the peripheral veins, as, for instance, on the dorsum of the hand, giving rise to the *venous pulse*.

The capillary pulse is produced by a large quantity of blood being propelled suddenly by a powerful ventricle into vessels in a state of low tension, and it may be somewhat dilated. Hence it is most likely to occur when with a slowly acting heart there is free regurgitation through the valves of the aorta with ample compensatory hypertrophy. When hypertrophy of the left ventricle fails and mitral regurgitation ensues the capillary pulse disappears.

Mitral Stenosis.—Considerable diversity of opinion has been expressed as to the character of the pulse in obstructive lesions at the mitral orifice. Some hold that the pulse, as a rule, is regular, though small, and that it is only when the compensatory conditions fail that irregularity takes place. The majority of observers, however, indicate irregularity as a very frequent condition even in cases where, as yet, no obvious cardiac embarrassment exists. Dr. Sansom, who has given much attention to the sphygmographic characters of the pulse in mitral stenosis, is very strongly of this opinion, stating (and in this he coincides with Mahomed) "that a pulse tracing which shows irregularity in the diastolic periods, sometimes missed pulsation, and, as described by Dr. B. Foster, the occasional appearance of a small abortive pulsation in the line of descent is very strong evidence of the existence of mitral stenosis." The writer has found, however, that in many cases of well-marked obstruction (at least so far as presystolic thrill and murmur with accentuation of the second pulmonic sound indicate such), while the patient is quiescent the pulse is regular. On exertion, excitement, or the supervention of pyrexia or pulmonary disorders, however, irregularities are readily induced. In advanced cases, marked irregularity is the rule. The size of the tracing will vary according to the quantity of blood delivered through the narrowed orifice to the ventricle, and to the efficiency of the ventricular contraction. Fig. 137 shows a tracing from a well-marked case in a young subject. The pulse to the finger was small but regular.

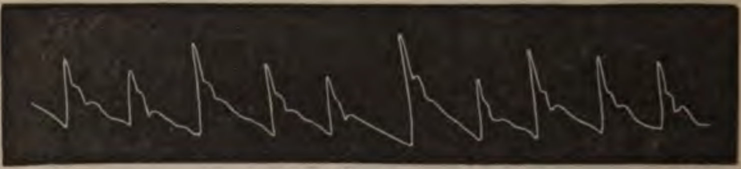
FIG. 137.



Mitral stenosis, patient aged sixteen, pulse 100, pressure 3 oz., well marked auricular-systolic murmur and thrill.

Mitral regurgitation gives no very distinctive sphygmographic characters, but the irregularity both in rhythm and force so frequently met with in such cases is well portrayed in the accompanying sphygmograms. In Fig. 138, the cardiac contractions are well sustained, but

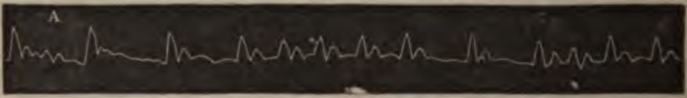
FIG. 138.



Tracing from a case of mitral regurgitation, showing the pulse irregular in force and rhythm.

present marked irregularities; while in Fig 139, the feeble, hurried, irregular pulse, indicative of free regurgitation and a failing ventricle, is well seen.

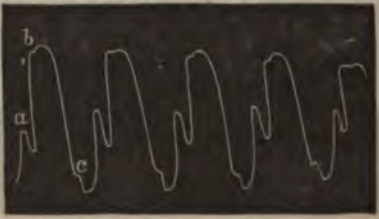
FIG. 139.



Mitral regurgitation, 1 oz. pressure, dropsy in feet, dyspnœa.

Venous Pulse.—Diseases of the right heart give no special characters to the arterial pulse, unless it be a tendency to undulation of the respiratory line; but tracings may be afforded by the jugular or subclavian veins in cases of tricuspid regurgitation.

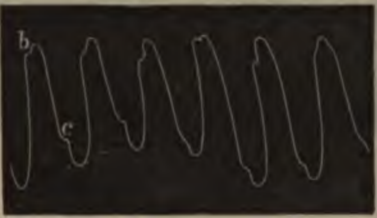
FIG. 140.



Jugular pulse-tracing showing the presence of the auricular wave *a*. (After Friedreich.)

In Fig. 140, the wave "*a*" preceding the main wave is due to the auricular contraction, and its proportions are indicative of the energy of the systole of the auricle; when it becomes dilated and paralyzed, the wave "*a*" disappears as in Fig. 141. The wave "*b*" is due to the contraction of the right ventricle, and the wave "*c*" in the descent line is said by Dr. Gibson to be reflected from the interior of the heart, in the same way as the dicrotic wave in the radial tracings of very free aortic regurgitation, as was first pointed out by Naumann.

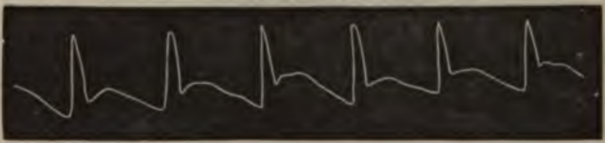
FIG. 141.



Jugular pulse-tracing after paralysis of the auricle; the auricular wave *a* in the preceding figure is no longer present. (After Friedreich.)

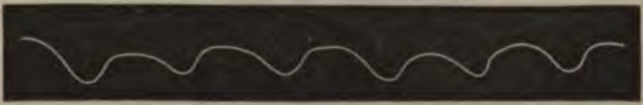
Aneurism of the arch of the aorta or of its main branches may modify the radial pulse; but the modifications will depend upon a great variety of circumstances, such as the site of the tumor, its size, its shape, the character of its walls and contents, etc. A frequent modification is inequality of the two radial pulses. (Figs. 142, 143, 144, and 145.)

FIG. 142.



Aneurism: right radial pulse.

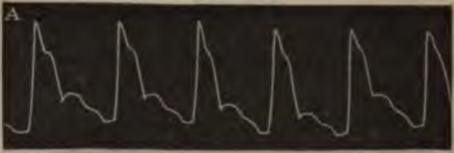
FIG. 143.



Aneurism: left radial pulse.

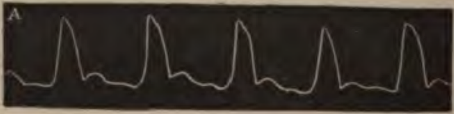
Should the aneurism be situated on the arch of the aorta below the origin of the innominate artery the two radial tracings may be quite equal in all respects. If, however, the aneurism involves the innominate, the right radial will give indications of the retardation of the pulse wave; while if the aneurism is situated so as to involve the left subclavian (as it did in Fig. 143) the left radial tracing will be modified to a greater or less extent. In Fig. 143, the sloping ascent, rounded apex, and unbroken diastolic line give graphic illustration of the great interference with the pulse wave on the affected side.

Fig. 144.



Aneurism: right radial pulse. 3 oz.

Fig. 145.



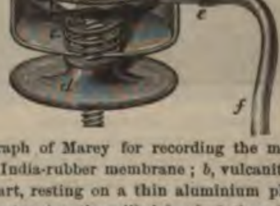
Aneurism; left radial pulse. 3 oz.

THE CARDIOGRAPH.

This is by no means such a reliable instrument as the sphygmograph, and its employment, consequently, in clinical inquiry is much more restricted. Several forms of cardiograph have been devised, but those of Marey and Galabin are, on the whole, the most satisfactory.

Marey's cardiograph is shown in Fig. 146; and the adjustment of

Fig. 146.

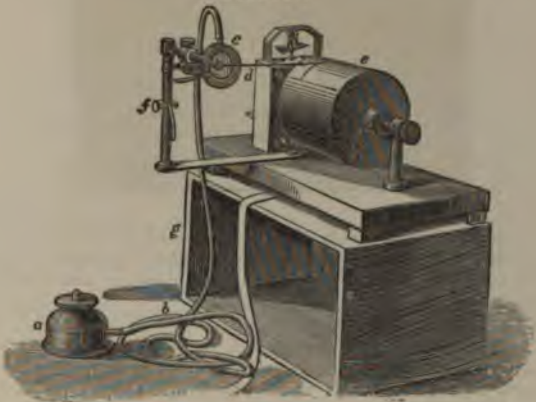


Section of the cardiograph of Marey for recording the movements of the heart of man or of animals. *a*, India-rubber membrane; *b*, vulcanite or ivory knob applied over the apex of the heart, resting on a thin aluminium plate; *c*, spiral, which may be tightened or relaxed by turning the milled head, *d*, thus increasing or diminishing the sensibility of the instrument; *e*, *f*, tube leading to the registering tambour. (MacKendrick.)

the apparatus with a registering tambour is represented in Fig. 147. It is thus seen to consist of two tambours. Any impulse communicated to the first tambour, which is applied immediately over the apex beat, is at once transmitted to the registering tambour which controls the writing lever and thus records the tracing on the drum.

Fig. 148 presents a tracing taken after this fashion.

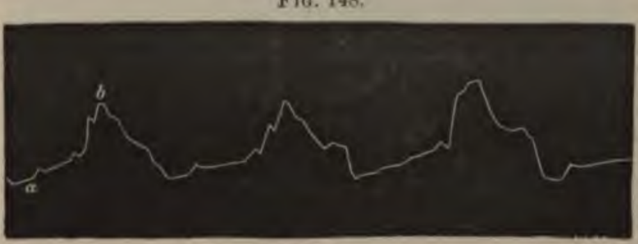
Fig. 147.



Arrangement of apparatus for recording movements of the heart by the cardiograph of Marey. *a*, Cardiograph; *b*, tube, communicating with *c*, recording tambour; *d*, clockwork, moving cylinder, *e*; *f*, fine adjustment screw for bringing lever of registering tambour on surface of cylinder at the proper time; *g*, box, in which the whole instrument may be packed. (MacKendrick.)

Galabin's cardiograph is a modification of the principle of Marey's sphygmograph. It will be found figured and described in the *Medico-Chirurgical Transactions*, vol. lvii. p. 359, and also in Bramwell's *Diseases of the Heart*, p. 754.

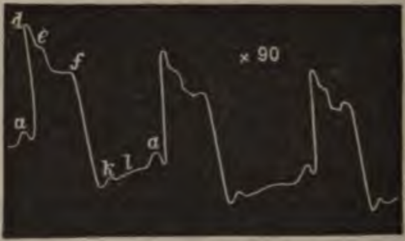
Fig. 148.



Tracings of the cardiac pulsations of a healthy man. (Marey.) The differences in form between the first two pulsations and the last are due to respiratory influences. *a*, diastole; *b*, ventricular systole. (MacKendrick.)

Pond's sphygmograph in cases where the apex impulse is limited and well marked can readily be *used as a cardiograph*. It is held in position by the hand, and gives, on the whole, very fair results.

FIG. 149.



Normal cardiographic tracing after Galabin. *a* represents the auricular contraction; from *a* to *d* indicates the sudden hardening of the ventricle; *d*, *e*, *f*, shows the continued systole; *k* is the rebound after the emptying of the ventricles; and *l* is the gradual ascent from the influx of blood during the diastole.

In order to secure a good cardiogram the patient must be placed in that position in which the cardiac apex beat is most definite. He may, therefore, require to sit up, or lean forward, or lie somewhat over to the left side. The cardiograph must be applied over the site of maximum impulse; and, if possible, the tracing should be taken during complete expiration, and while the breath is held. This assures the nearest approximation of the heart to the chest wall, and at the same time obviates respiratory undulations, and other modifications of the tracing.

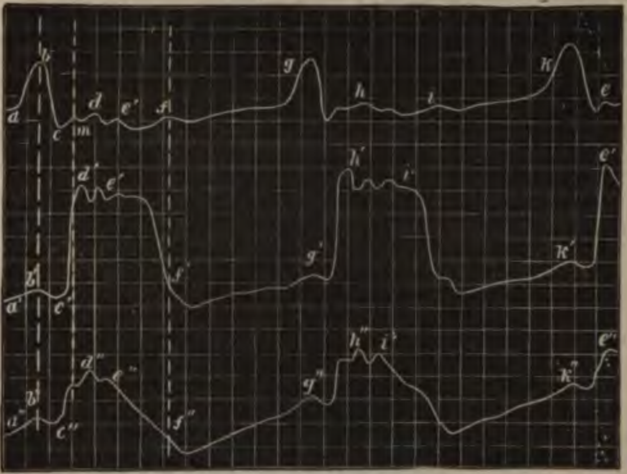
Fig. 149 is a cardiogram after Galabin.

It is to be remembered, however, that in cases where the button of the cardiograph is not applied exactly over the site of greatest apex impulse—as when the heart beats behind a rib—the tracing is apt to be inverted and must be read accordingly. In other instances the inversion may not be complete and the interpretation of the tracing becomes a matter of much difficulty.

Observers are by no means agreed as to the exact causation of the various waves in a normal cardiogram; but Fig. 150, with simultaneous tracings from the right auricle, right ventricle, and apex beat, will serve to some extent to show the relation of the various phenomena; while Fig. 151, giving simultaneous tracings of the cardiac apex, radial pulse, and the respiration, exhibits the relation in time of the cardiac contraction to the pulse at the wrist; and serves also to show the alterations in the cardiogram induced by the respiratory movements.

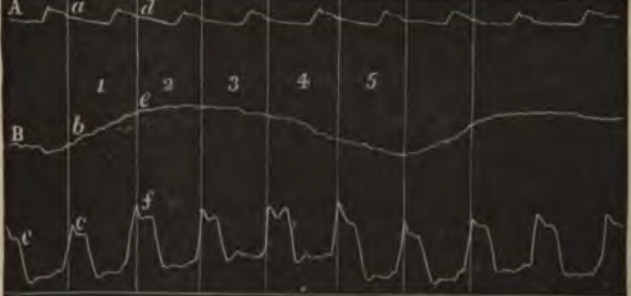
The whole subject of cardiography is still too much in a state of flux to permit of any very precise statements. No doubt it affords some valuable data as to the relative duration of the cardiac systole and diastole; as to the mode in which the ventricle is being filled during

Fig. 150.



Tracings obtained from the heart of a horse by Chauveau and Marey. The upper tracing is from the right auricle, the middle from the right ventricle, and the lower from the apex of the heart. The horizontal lines represent time, whilst the vertical represent amount of pressure. The vertical dotted lines mark coincident points in the three movements. The breadth of one of the small squares equals one-tenth of a second. *a b*, *a' b* , *a'' b''*, auricular systole ; *c d e f*, *c' d' e' f'*, *c'' d'' e'' f'*, ventricular systole : similar waves in the other curves have different letters. (MacKendrick.)

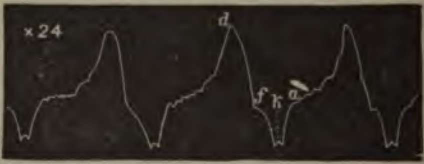
Fig. 151.



Simultaneous tracings taken by the pneumograph B, cardiograph C, and sphygmograph A at the radial artery. The ascent of the curve in B corresponds to expiration, and the descent to inspiration. There are from four to five cardiac pulsations to each complete respiratory movement. Observe also that the pulsation at the wrist is a little later than the corresponding cardiac pulsation—thus *d*, in upper line A corresponds to *e*, in lower line C. (MacKendrick.)

the diastole; as to the condition of the mitral orifice, and the state of the cardiac muscle generally; but the results, on the whole, are too conflicting to admit of generalization, and much careful experiment will be required before anything like precise doctrine is attained. Mitral obstruction and aortic regurgitations give two of the most characteristic cardiograms. Fig. 152 (from Bramwell after Galabin) is from a case of mitral stenosis with loud harsh murmur extending through the long pause. *a* indicates the probable commencement of the auricular contraction, which is represented by a prolonged, ascending, serrated line, the visible expression of the long rough murmur. This indicates the lengthened systole of the auricle necessary to drive the blood through the narrowed mitral orifice. Many variations, however, are found.

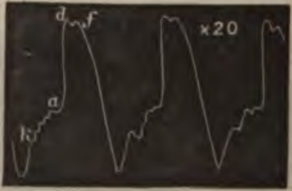
FIG. 152.



Cardiogram from a case of mitral stenosis. *a* represents the auricular contraction: for the other letters see Fig. 149. (Galabin.)

A tracing from a case of well-marked aortic regurgitation is seen in Fig. 153 (from Bramwell after Galabin). It will be noticed that the summit of the tracing is here sustained, having two peaks, *d* and *f*, indicative of hypertrophy of the ventricle, while the filling of the ventricle during diastole is indicated by the rapid ascent of the diastolic line "*k*."

FIG. 153.



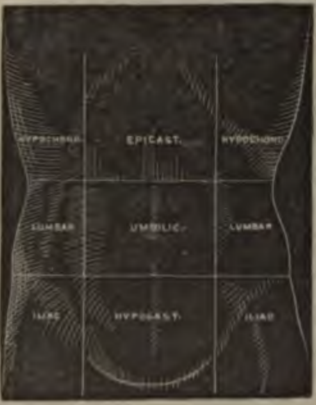
Cardiogram from a case of aortic regurgitation. (Galabin.)

For further details as to the cardiograph and its revelations the student is referred to the authorities indicated.

PART III. PHYSICAL EXAMINATION OF THE ABDOMEN.

Anatomists have divided the abdomen into various regions by lines drawn from certain fixed points, viz., two horizontal lines passing across the body, the one at the lowest point of the costal arch, and the other at the highest part of the iliac crests; two vertical lines are drawn, one on either side, from the cartilage of the eighth rib to the middle of Poupart's ligament. The central regions are the epigastric, the umbilical, and the hypogastric, and on either side of these the right and left hypochondriac, lumbar, and iliac. (See Fig. 154.) Some clinical observers have devised other lines for these divisions, but the difference in the regions is only slight. (See the dotted lines in Bright's diagram, Fig. 71.)

FIG 154.



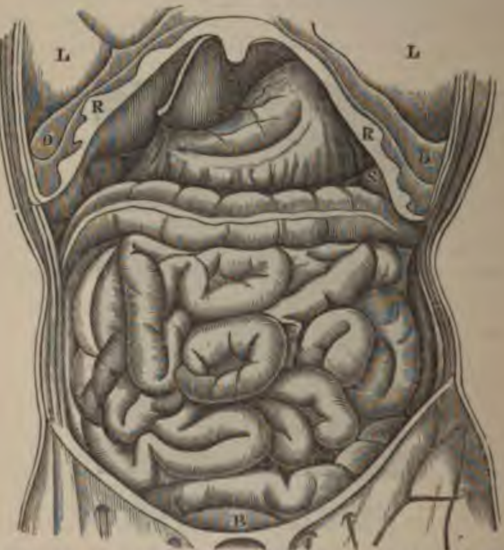
The anatomical regions of the abdomen.

It is well to have a general notion of what organs occupy these regions. In the *right hypochondrium* lies the right lobe of the liver; in the *epigastric region* the body of the stomach, the left lobe of the liver, and behind the stomach the pancreas; in the *left hypochondrium* the cardiac extremity of the stomach and the spleen; in the *umbilical region* the transverse colon, the mesentery, and part of the small intestine; in the *right lumbar* region the right kidney and the ascending colon; in the *left lumbar* region the left kidney and descending colon; in the *hypogastrium* the small intestine and the bladder when distended; in the *left iliac* region the sigmoid flexure; and in the *right iliac* region the "caput cæcum coli." (See Fig. 155.)

The methods employed in the physical examination are similar to those already indicated in the case of the chest—viz., *inspection*, *palpation*, *percussion*, *mensuration*, and *auscultation*. The last of these is of very limited scope in the abdomen compared with the chest, but all of them should be used so as to check each other at every step of the inquiry.

Before commencing the examination the patient should, as a rule, be laid on his back, with the shoulders a little raised, and the thighs slightly flexed on the pelvis to relax the abdominal muscles. He should be directed also to keep his mouth open, and breathe quietly.

FIG. 155.



Abdominal viscera in situ. The omentum has been removed; the costal arch has been preserved. The capital letters are the initials of the structures on which they are placed: L, lungs; D, diaphragm; R, ribs; S, spleen; B, bladder. (From Marshall's "Physiological Diagrams.")

INSPECTION.

The abdomen being well exposed, inspection will determine its shape, the condition of the superficial parts, the respiratory movements, and any other movements or pulsations which may exist. In healthy women and children the abdomen protrudes more than in adult males, in whom, in the recumbent posture, it is often somewhat flattened. If the subject is fat, the surface will be free from marked inequality; but if the parietes contain little fat, and the recti muscles are well developed, they may stand out somewhat on either side of the middle line.

General distention of the abdomen may result from accumulation of gas in the intestines (see "Tympanites," p. 633), or from fluid effusion into the peritoneum (see "Ascites," p. 435), or from ovarian tumors (see pp. 439, 634), or from combination of these; or the *bulging may be local* from tumor of some of the solid organs, or from undue distention of some of the hollow viscera, such as the stomach in stricture of the pylorus. On the other hand *the abdomen may become much retracted* in certain cerebral affections (tubercular meningitis), in chronic lead poisoning, and in cases of obstruction high up in the alimentary canal leading to inanition. The *umbilicus* occupies a point about midway, as a rule, between the pubes and the xiphoid, but is subject to a certain degree of variation, and in very young children is nearer the pubes. In the strictly normal condition it is depressed, but it may bulge as in umbilical protrusion, and in cases of ascites. During the later months of pregnancy, also, it becomes prominent. The skin is normally somewhat darker round the umbilicus than on other parts of the abdomen, forming what is called an "areola," and this *pigmentation* becomes more marked during the course of pregnancy; and in Addison's disease (see p. 142) it is a marked feature—the whole surface, however, being unduly pigmented. In women "a brown line" is occasionally seen extending from the umbilicus to the pubes, and is by some reckoned a sign of pregnancy; but this is to be accepted with reservation; it is sometimes present even in males. In women who have borne children the abdominal walls are often very flaccid, and in some cases, after many pregnancies, become so thin as to give the impression that there is little else than a layer of skin covering the intestines. *White lines* (lineæ albicantes) or "water lines" occur on the skin after the distention of pregnancy, and after the absorption of large dropsical effusions. Occasionally the *superficial veins* (epigastric and mammary) are much enlarged and tortuous, or even varicose, this condition being generally associated with some obstruction to the portal circulation, as in cirrhosis, or with some pressure on the inferior vena cava by tumors. The abdominal parietes may be *dropsical*, and pit on pressure. This œdema is always greatest in the dependent parts, often accompanied by fluid effusion into the cavity of the peritoneum, and usually associated with dropsical effusion into the cellular tissue of other parts of the body. The abdomen is frequently the seat of skin *eruptions*; some of the febrile rashes indeed, as enteric fever, have a tendency to appear there first. All such rashes, of course, should be noted and described if present.

The degree to which the abdominal walls participate in the *respiratory movements* should be observed. In quiet respiration in males the abdominal movement is more marked than the thoracic; while in females the thoracic movement predominates. The type in the male is thus said to be "abdominal," and in the female "thoracic." This abdominal movement may be affected by various conditions. Anything which causes distention of the abdomen, and impedes the descent of the diaphragm, will necessarily restrict it; all forms of abdominal intumescence will have this effect. In women the respiration is made more thoracic by the presence of pregnancy and ovarian or uterine tumors. But apart from such causes, the abdominal movement may be greatly restricted by voluntary effort, owing to the pain which it excites, as in peritonitis, diaphragmatic pleurisy, or pericarditis. But this abdominal respiratory movement may be exaggerated when from any cause the thoracic movements are restricted, and the chief work of the respiratory process is thrown upon the diaphragm. This is the case in large pleural effusions, in extensive consolidations of the lung, and in emphysematous and asthmatic conditions.

A degree of *pulsation* is occasionally visible in the epigastric region, and may be due to the heave communicated from the aorta. It is most frequently seen in females, especially those who are thin and of nervous temperament; it must not be confounded with the epigastric pulsation communicated from the heart. (See p. 341.) But visible pulsation may exist in the abdomen from aneurism of the aorta or any of its branches; and cancerous or other tumors may simulate aneurismal conditions from their lying over the vessel and having its impulse communicated to them. All the methods of inquiry must be brought to bear on the investigation of such cases. In certain instances of extreme tricuspid incompetency an expansile pulsation may be quite perceptible in the liver, synchronous with the ventricular contraction, and due to the transmission of the pulsation through the inferior vena cava and hepatic veins. In subjects in whom the stomach or intestines are much distended owing to any obstruction, *peristaltic action* may occasionally be seen through the abdominal walls; this may also be visible in the extremely thinned condition of the integuments already referred to.

PALPATION

is a method of investigation widely applicable in abdominal diagnosis, and should be followed out with much detail. The hands of the examiner should not be cold, as this is apt to cause the patient to shrink; and the palpation should not be conducted, at least in the first instance, in a jerky or spasmodic manner with the tips of one or two fingers, but with the whole palmar surface of them applied gently, but firmly. As the results of this method of examination will be given in detail under the various organs, only a few general facts need be noted here. It will determine the state of the temperature of the surface, the presence of flaccidity or rigidity of the walls, of the condition of the abdominal rings, the degree of resistance at different points, and whether parts are freely movable. When associated with percussion it enables us to detect fluid in the peritoneum. (See "Ascites," p. 435.) It will reveal the fact of smoothness or irregularity of the abdominal organs, will determine the presence and character of pulsations, and sometimes even detect peritoneal friction. This last-mentioned condition is got either by causing the patient to breathe forcibly while the flat of the hand is laid over the suspected organ, or it may be elicited by sliding the abdominal wall over the part. (See p. 439.) In the case of abdominal tumors palpation will determine their characters, and whether they are affected by respiration or not; tumors closely associated with the movable organs lying beneath the diaphragm being depressed and elevated in respiration. Palpation may also determine the fact of pregnancy by noting the movements of the fœtus in the uterus, as well as enabling us in certain cases where the abdominal walls are thin, or in an extrauterine fœtation, to recognize the head or other parts of the child. It also elicits important information as to the presence or absence of pain or tenderness. In certain conditions pain is so acute as to forbid palpation. This is especially (but not invariably) the case in acute peritonitis, where the pain is often so exquisite as to lead the patient to flex the thighs upon the pelvis in order to relax the abdominal muscles and protect the belly from the pressure of the bed-clothes. On the other hand, acute pain when of the neuralgic or colicky type is sometimes relieved by pressure. If tenderness on pressure exists over a limited area in the epigastric region, it may point to the presence of gastric ulcer; and in inflamed or suppurating conditions of any of the organs or structures in the abdomen, pain on pressure is, as a rule, a marked feature.

PERCUSSION

is to be performed in the manner described in the section on the physical diagnosis of the lungs. The note yielded by the air-filled organs in the abdomen is "tympanitic," having a distinct musical tone, and the quality of this note varies according to the size and degree of distention of the organs. The note obtained over the stomach is fuller and lower in pitch than that over the colon; the note over the colon bears a similar relation to that over the small intestine. It is by means of this change in quality that the different parts of the intestine can be distinguished from each other, and the student should study them in this light, contrasting the percussion tone also with that obtained over a solid organ such as the liver, which is "dull," and that elicited from the lung, which is termed "clear." Auscultatory percussion is sometimes of value in the delimitation of air-filled organs. (See p. 619.)

MENSURATION

is used to determine the circumference of the abdomen, the tape being applied to the most prominent part, usually a little above or below the umbilicus, or at some other definite point such as the umbilicus itself. This gives a datum for future measurements, and increase or decrease can readily be determined, care being taken that the tape is applied at the same level and with the same tension. The distance of the umbilicus from the ensiform cartilage, the symphysis pubis, or the iliac spines has occasionally to be noted. The areas of percussion-dulness of the various organs, whether normal or abnormal, should be accurately measured and stated; the points to be indicated should be measured from definite anatomical landmarks such as the umbilicus, ensiform cartilage, iliac spines, etc., and not vaguely referred to the regions in which they lie.

AUSCULTATION

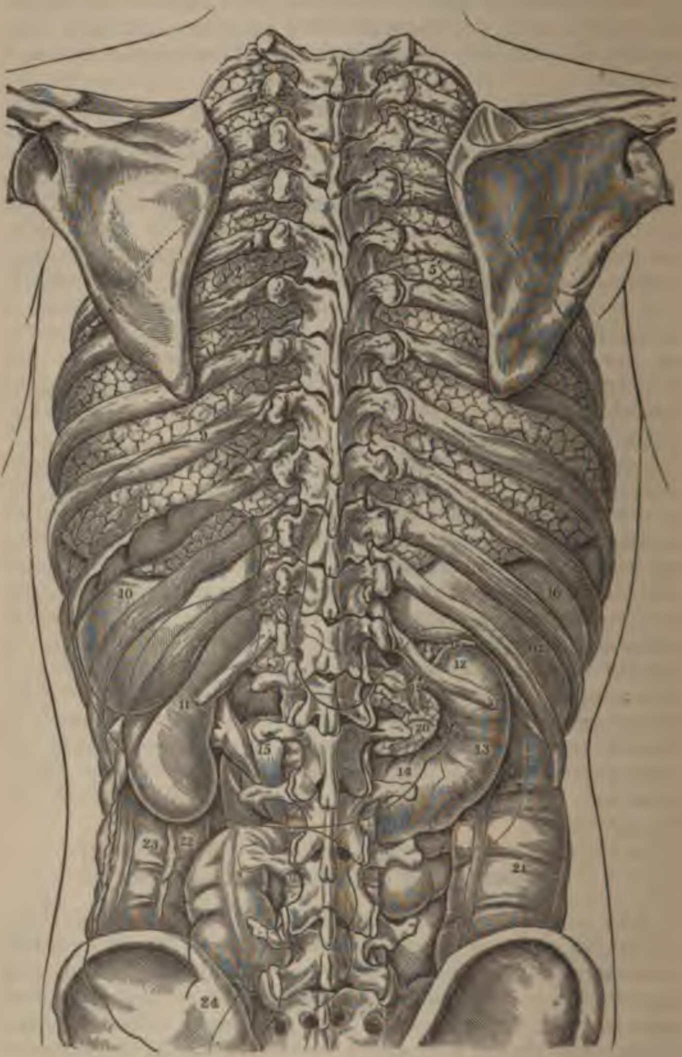
is of great value in abdominal diagnosis in the detection of vascular sounds, whether connected with abnormal conditions such as aneurism, uterine tumors, etc. (see pp. 635, 636), or with normal conditions during pregnancy (the fœtal heart, uterine souffle, etc., see p. 524). It is also applicable in dilatation of the stomach in practising succussion; the sounds in the bowels are also of importance, particularly in cases of intestinal obstruction. Auscultation is also useful occasionally in the determination of peritoneal friction, particularly over the liver. It may be used in the diagnosis of stone in the bladder, the stethoscope being placed above the pubes, while the stone is struck with the sound.

"Auscultatory percussion" is sometimes used to delimit air-filled organs, such as the stomach. For this purpose the observer places his stethoscope over the epigastrium while an assistant percusses from the periphery, till a point is reached at which the note is communicated with sudden and great directness to the listener, and this may be marked as the limit of the air-filled portion of the organ. The same method is pursued all around the stomach, the patient's position being altered to allow the fluid to change its place, and the area occupied by the viscus can thus be mapped out with tolerable exactitude, if the note of the colon does not approximate to that of the stomach. It is absolutely necessary to shift the patient from one side to the other in this examination, otherwise only the level of the fluid contained in the stomach will be ascertained.

EXAMINATION OF ABDOMINAL ORGANS.

The most convenient method of treating further of abdominal diagnosis is to take up the principal organs in detail, considering them first in their normal relations, and then passing on to abnormal conditions. The student may find assistance in understanding their position by reference to the anatomical figures here given, and especially to the posterior view of the viscera. (Figs. 155, 156.)

FIG. 156.



Posterior view of viscera. (Reduced by photography, from Luschka.)

1. Upper lobe of left lung.
2. Under lobe of left lung.
3. Interlobular fissure of left lung.
4. Upper lobe of right lung.
5. Under lobe of right lung
6. Middle lobe of right lung.
7. Superior fissure of right lung.
8. Inferior fissure of right lung.
9. Stomach, represented in outline, more vertical than usual.
10. The spleen at its ordinary distance from the vertebræ, and in the course of the 9th, 10th, and 11th ribs; its relation to the left lung in expiration is shown; the left kidney, partly shown in outline, appears through it. It must not be forgotten that in this view from behind the spleen appears only after the removal of the diaphragm.
11. The left kidney in so far as not covered by spleen (the covered part is indicated in outline); the pelvis of the kidney and commencement of the ureter passing out from it are shown; kidney on the right side has been removed to show deeper parts, but its position is indicated in outline.
12. Superior horizontal portion of the duodenum.
13. Descending portion of duodenum.
14. Inferior horizontal part of duodenum.
15. The duodeno-jejunal flexure.
16. Liver.
17. Hepatic duct.
18. Cystic duct.
19. Common bile duct.
20. Head of pancreas; the rest of its course shown in outline.
21. Ascending colon.
22. Descending colon.
23. Posterior surface of descending colon uncovered by peritoneum.
24. Knuckle of colon forming sigmoid flexure, covered by left iliac bone.
25. ortion of the sigmoid flexure.

Liver.

In the section devoted to the physical examination of the lungs it was noticed that the pulmonary percussion was bounded inferiorly all round the right side by the upper margin of hepatic dulness. In order to define this margin, the percussion should be carried from the clear pulmonary area down on to the dull liver, using a *light* stroke, and at a point one inch and a half or two inches below the right nipple, a change will be perceived in the note, as well as in the sense of resistance, and this indicates the spot at which the lung ceases to overlap the liver. This is the boundary of "*absolute*" dulness; the deep or "*relative*" dulness, which indicates the highest point to which the liver ascends under the diaphragm, is at a considerably higher level than this, and is ascertained by means of strong percussion performed during expiration. The description here given will apply to superficial percussion and to the absolute dulness. The upper border is followed into the cardiac dulness in almost a straight line—there being, however, a tendency for it to descend a little toward the inner extremity, where it joins the precordial dulness on a level with the base of the ensiform cartilage. It is then extended in the lateral region and the back, and will be found to descend somewhat as it nears the spine, usually at the tenth of eleventh dorsal vertebra. Having marked this upper limit of percussion with ink or pencil, the lower margin will next engage attention, the percussing stroke being carried up from the tympanitic intestine. This lower margin in the right mammary line will be found to coincide pretty exactly with the margin of the ribs; in the axillary line it corresponds to about the tenth intercostal space, and it crosses the epigastrium at a level of about two inches below the xiphoid, and joins the left margin of the cardiac dulness. (See Fig. 102.) The left lobe of the organ can thus be felt in the epigastrium, giving a sense of increased resistance; but in health its lower edge cannot, as a rule, be strictly defined by palpation.

The average extent of hepatic dulness, according to this mode of percussion, in a healthy adult of medium size, is from 2½ to 3 inches in the mesial line of the sternum, 4 inches in the line of the nipple, and 4½ or 5 inches in the axillary line.

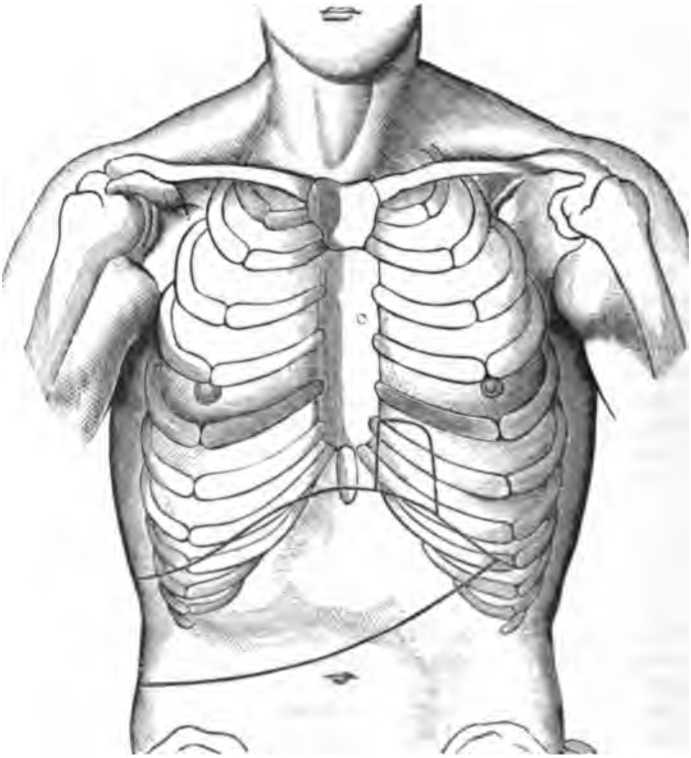
It must be remembered that these limits, which presuppose the recumbent posture, may alter to some extent on the patient's assuming the erect attitude, and in certain conditions of respiration. Thus, on deep inspiration the whole organ is somewhat depressed, and its upper limit overlapped to a greater extent by the lung; the student ought to study these changes. In children, in whom the liver is naturally large, the upper margin of dulness may approximate to the nipple, and the lower descend somewhat beneath the costal arch; and there are various deformities of the chest, such as those induced by rickets, emphysema, and tight lacing, which tend to throw the organ to a greater or less extent from under the cover of the ribs, and so simulate enlargement. Congenital malformations of the organ may also be present.

The demarcation of the lower edge of the liver should never be considered as settled from a single examination, as there are various conditions which temporarily affect it. Thus, if the stomach and intestines are distended with gas, they may conceal the lower edge, and the area of dulness may appear diminished. Again, if the examination is made after a full meal, the dull percussion from the stomach may mask the lower edge of hepatic dulness; or there may be accumulation of feces in the colon having a similar effect. In cases of thickened omentum also, or where the recti muscles are very rigid, or where there is dropsy of the abdominal wall or of the peritoneum, the exact determination of the lower edge may be very difficult or even impossible.

Large abdominal tumors, by their pressure upward, will tend to push the liver further under the ribs, and so raise both its upper and lower limits of percussion; while pleural effusions of air or fluid, marked emphysema of the lungs, tumors in the chest, and enlargements of the heart, will depress the organ into the abdomen. The diagnosis in such cases must be guided by the history and other physical signs.

The size of the liver is liable to vary to some extent, even in health, under the influence of diet; but this is only temporary. In all cases where the liver is permanently increased in bulk, the enlargement is, as a rule, chiefly in the downward direction—the liver projecting beyond the ribs, and palpation becoming a valuable means of diagnosis.

FIG. 157.



Displacement of cardiac and hepatic dulness in emphysema of the lungs. (Weil.)

nt must be careful to distinguish enlargement
ment of the organ. The distinction in cases of
tight lacing, and rickety or other deformities of
in the fact that in *displacement* the upper level
lness will be found to be lowered to a greater or
ccording to the degree of projection from under
Fig. 157); whereas, in *enlargement*, the upper
ess maintains its position, and in some instances
higher level, approximating to the nipple.

displacement is due to right pleural effusion, the
ay be less easily drawn, as the upper border of
is merged in that of the effusion; but the history,
d other physical signs will usually give the key
on. In pericardial effusion, hypertrophy of the
t pleural effusion, the left lobe is the part chiefly
d, as the upper limit of the right is not much
is not the same liability to fallacy as in pleural
e right side. (Compare Figs. 105 and 106.)

ement of the liver may affect the whole organ uni-
ay be localized, and it may be moderate in extent,
ole abdomen. When the liver is uniformly en-
tline of the organ is not materially altered. The
its limits should be followed out, and palpation
s be brought to test the lower margin; in not a
it will be found that the lower edge can be felt

sible, by applying the one hand in front and the other in the lumbar region behind, to grasp the organ and communicate a sense of impact from the one hand to the other.

Density, Smoothness, or Irregularity.—The hepatic region in cases of enlargement can often be seen distinctly bulged, and, on applying the hand over the part that projects, the sense of resistance and the fact of smoothness or irregularity of the surface may be recognized. *If the organ is smooth*, uniformly enlarged, dense and resistant, it is most probably either amyloid, fatty, or congested, or the seat of simple hypertrophy, as in leukæmia; the fatty liver is usually the softest of these; the amyloid is, as a rule, the most dense, and it is often associated with enlargement of the spleen and with albuminuria. If, on the contrary, *the surface of the organ is irregular*, nodules of varying size existing on its surface, and in some instances projecting beyond its lower edge, and especially if some of these nodules can be felt to be depressed or umbilicated in the centre, and if palpation elicits a degree of pain or tenderness, then there is strong ground for the suspicion of cancerous disease of the liver. If, however, the irregularities on the surface are small, and associated with symptoms of obstruction to the portal system, such as ascites, enlargement of spleen, hemorrhage from the stomach or bowels, etc., then it may be a case of cirrhosis, or "gin-drinker's liver," although this disease is not, as a rule, attended by enlargement, but rather by atrophy. Uniform enlargement is apt to occur in all cases in which there is obstruction to the systemic circulation; and so in diseases of the heart, especially of the right side, it is a very frequent fact, the constant congestion of the portal system giving rise to it. This may also occur from persistent dietetic excesses, and an enlargement from alcohol is very common.

The enlargement may not be uniform, but only involve one or other lobe. This is especially the case in hydatid disease and tropical abscess. In both instances a distinct tumor often exists, and if it lies near the surface, fluctuation, or at least a sense of elasticity can be felt; in the case of hydatid cysts there is sometimes detected on percussion a sense of tremor called "hydatid fremitus." This is elicited by laying three fingers over the seat of greatest distention and percussing strongly over the middle finger. The affections are differentiated by the grave constitutional symptoms and local tenderness in the case of abscess, and the almost total immunity from them in the case of hydatid disease.

With or without enlargement of the liver there may be present a projection of dull percussion and increased resistance from its under surface. If this arises from the region of the gall-bladder, if it conveys the sense of fluctuation or elasticity, and is pyriform in shape and tender to pressure, it is most probably the gall-bladder enlarged from obstruction to its duct. In some instances gall-stones are also present in the sac, and crepitation may be elicited sometimes from the rubbing of these on each other. A history of hepatic colic, and perhaps even the passage of gall-stones, may serve to throw light on the case. (See Chapter XII., p. 425.)

Diminution in the size of the liver can never be so certainly stated as enlargement, as the area of hepatic dulness is apt to be much encroached on by emphysematous lungs or distended intestine. But actual diminution in size often takes place. This is especially the case in cirrhosis and other forms of chronic atrophy and in acute yellow atrophy of the liver. This latter condition is very rare, acute in its course, and associated frequently with jaundice and with symptoms of great vital depression; the atrophy may become extreme. It occurs chiefly in females, and pregnancy is a predisposing cause. In cirrhosis the atrophy is not extreme, it is not acute in its course, and there is often a history of spirit drinking.

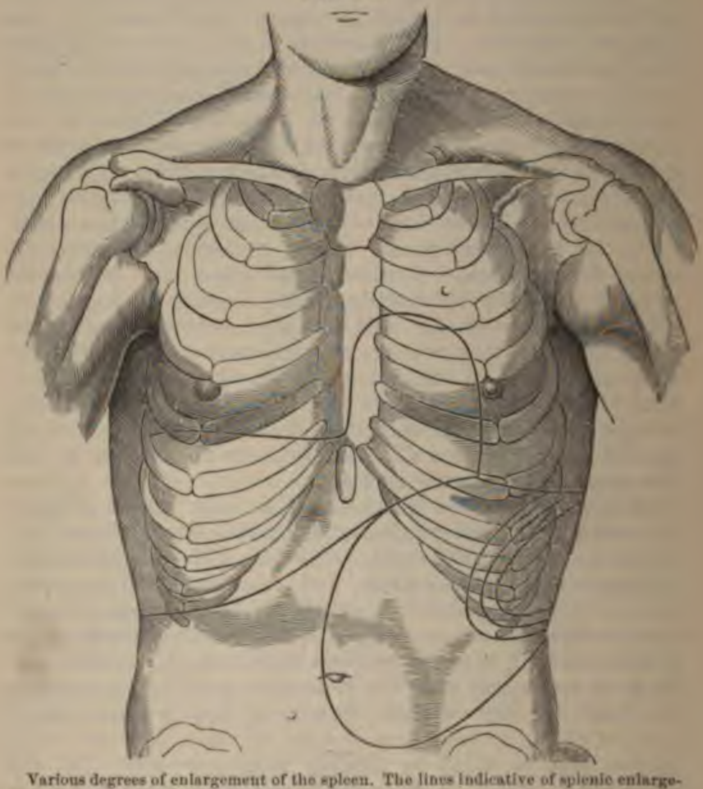
The presence or absence of pain or tenderness in diseases of the liver must be investigated. Murchison makes this the ground for his division of enlargements of the liver into "painful" and "painless." Among the "painless" there are the so-called amyloid liver, the fatty liver, hydatid tumor of the liver, and simple hypertrophy. Among the "painful" there are congestion, catarrh of the bile-ducts, interstitial hepatitis, pyæmic abscess, tropical abscess, and cancer. He also remarks that painless enlargements are characterized by an absence of jaundice and ascites, and by a chronic course, whereas in painful enlargements jaundice and ascites are common symptoms, and the progress is more rapid.

Spleen.

In the normal subject the spleen can be detected by percussion only, as it lies quite under cover of the ribs in the left hypochondrium, its convex surface corresponding with the ninth, tenth, and eleventh ribs. Prior to attempting its delimitation, it is well to determine the percussion of a line passing from the left axilla downward and inward to the umbilicus. This line will necessarily be oblique, and if required it may be curved to carry it outside the areas of cardiac and hepatic dulness, both of which should be defined before attempting the percussion of the spleen. This line will be found to be more or less resonant throughout; in its upper part pulmonary resonance is obtained, and then passing across the stomach, colon, and small intestines, the differences in the tympanitic note of these organs may be more or less distinctly realized. The presence of such a resonant line removes various sources of fallacy from pleuritic or pericardial effusions, pulmonary condensations, enlargement of the left lobe of the liver, fluid or solid accumulation in the stomach, etc. Having determined this line, light percussion should be made backward and downward from it toward the splenic region, till a change in the note is discovered; the percussion should then be carried down from the axilla on to the upper margin of spleen, or rather to the point where the lung ceases to overlap the organ; and percussing upward from the tympanitic abdomen into the hypochondrium, the lower border will be found normally inside the costal arch. The posterior margin cannot be ascertained with any degree of certainty. In the average subject this area of dulness will measure from two to three inches in the oblique diameter, but this dulness varies greatly even in normal conditions, and slight increase or decrease in its size can never be confidently stated.

Enlargement of the spleen is, as a rule, almost entirely downward and forward, unless it is very firmly bound by adhesions to the diaphragm. (See Fig. 158.) Considerable enlargement may take place, and may be detected by percussion alone, unaided by palpation, as the organ lies so much inside the margin of the ribs as to admit of considerable increase in bulk before it projects from under the costal arch. Even in such cases, however, it is often possible by pressing the finger-tips well up under the costal arch to make out a sense of increased resistance or even of tumor, and the examination may be aided by making counter-pressure with the other hand behind. In moderate enlargement percussion plays the principal part in the diagnosis: when, however, the organ passes below the ribs, palpation becomes of prime importance, and with one hand in front and the other behind, the organ can be grasped and tilted backward and forward. The enlargement may be so great as to fill the whole left side of the abdomen down even to the pubes, and the fact of its being a spleen may be somewhat obscure, but if the enlargement is moderate there is usually little difficulty in determining the organ involved. A tumor arising from the left hypochondrium, which is superficial and mobile, with rather blunt edges, and with a notch in its anterior border, can hardly be anything else than spleen. The most likely sources of fallacy are enlarged or floating kidney, and fecal accumulations in the splenic flexure of the colon.

FIG. 158.



Various degrees of enlargement of the spleen. The lines indicative of splenic enlargement are copied exactly from Weil, but the percussion limits of the heart and liver have been somewhat modified.

There are certain conditions in which palpation can detect the spleen when not enlarged but displaced. In certain deformities of the chest, as in rickets, the spleen may be thrown to a greater or less extent from under cover of the ribs, in the same way as the liver. In like manner large pleural effusions in the left side of the chest will depress the spleen and bring it within reach of palpation. It is to be remembered, also, that in very rare instances the spleen, owing to relaxation of its ligaments, may be greatly displaced, constituting what is known as "movable spleen."

In emphysematous states of the lungs, or great distention of the intestines with gas, the splenic dulness may be much encroached on and thus appear diminished.

Causes of Enlargement.—Enlarged spleen may arise from passive congestion, as in obstruction to the portal system from cirrhosis of the liver. It may originate also from active congestion, especially in certain specific fevers such as enteric and relapsing, and above all in ague; the constantly recurring congestion in this last affection may lead ultimately to chronic enlargement ("ague cake"). But the increase in volume may be due to splenic leukæmia, in which case the diagnosis is aided by the discovery of increase in the white blood-corpuscles; or it may be from amyloid disease, and here the liver will most probably also be enlarged, and the urine will usually be found to contain albumen from a similar condition in the kidney. Colloid cancer, inflammation, and, in very rare cases, abscess of the spleen may also lead to enlargement. Embolism of the spleen may give rise to considerable enlargement, and in such cases friction may sometimes be detected over the organ in the early stage. In young children of rachitic habit the organ is often considerably enlarged as well as displaced.

The Kidneys

lie so deep in the lumbar regions, and in such close proximity to solid structures, that they often cannot be marked out by percussion in the natural condition with anything like accuracy. The patient should be laid flat on his face, with all the lumbar muscles well relaxed; the tympanitic note of the colon is realized, and the percussion carried backward to the anterior edge of the kidney. The upper edge is approached in a like manner, and is usually situated on a level with the first or second lumbar vertebra, and the anterior edge from three to four inches from the spine. It is to be remembered, however, that one or other kidney may be absent altogether, or atrophied from calculus, or may occupy some other position. Slight degrees of enlargement cannot be determined by palpation and percussion, especially if the patient is fat and the abdominal walls resistant. In most cases, indeed, the physical examination of the kidney is quite subordinate to the careful examination of the urine. There are instances, however, in which positive results can be got. Thus in cystic disease of the kidney, or hydro- or pyo-nephrosis, increased dull percussion and sense of tumor, or at least resistance, can often be made out. The way to detect this increased resistance, or sense of weight in the flanks, is to lay the patient flat on his back with the muscles quite relaxed; a hand is then applied to either lumbar region, and the one weighed against the other, when, if the case is at all well marked, there will be little difficulty in fixing on the heavier or more resistant. Sometimes, also, there may be distinct bulging. Having determined this, the affected flank is grasped between the two hands, one in front and one behind, close to the spine, and just below the ribs; sometimes the enlarged kidney can thus be felt, and the sense of impact made out on moving it from the one hand to the other. In cases of cystic disease, or hydro- or pyo-nephrosis, the organ may be greatly distended, distinctly fluctuant, or at least elastic, and it might be confounded with ovarian cyst, hydatid disease, or lumbar abscess; but its renal nature can usually be made out, and there may be elements in the urine to guide the diagnosis. If the disease arises from calculus in the ureter, there may be perhaps a former history of a like tumor relieved by a sudden and large discharge of urine; and symptoms of renal colic may have preceded the formation of the tumor. In pyo-nephrosis, also, it sometimes happens that there is a history of a similar large discharge of pus, with subsidence of the tumor; or at least variations in the quantity of pus excreted in the urine may occur, and this may guide the diagnosis. The kidney may also be enlarged from cancerous, sarcomatous, or hydatid disease. Perinephritic abscess may simulate renal tumor, but can usually be distinguished on account of its affecting the psoas muscle as indicated by flexion of the thigh on the pelvis.

The kidney may become displaced from relaxation of its ligaments, this occurring chiefly on the right side, and specially in women. *Floating kidney* is not always easy of diagnosis, but if there is an abdominal tumor in the umbilical region, smooth, ovoid, presenting the characters of the kidney, freely movable, capable of being replaced into one or other renal region, tender to pressure, but unattended by serious constitutional disturbance, although, perhaps, with occasional attacks of severe pain, then the suspicion of floating kidney should be entertained; this is all the more likely if we can determine by palpation an absence of the kidney in the lumbar region.

Pancreas.

In the healthy condition, physical diagnosis fails to detect the pancreas, or at least to give data of any importance; but when it is the seat of disease (chiefly cancerous), and the patient is emaciated, it may come to present a palpable tumor, lying across the upper part of the abdomen, chiefly in the epigastrium, very deep, and often receiving an impulse from the aorta or superior mesenteric artery. It is likely to be confounded with aneurism, but the pulsation may be determined to be not expansile, being simply a heave communicated to the tumor from the vessel. It may also be confused with other deep tumors, and in such cases the diagnosis can only be inferential. Tumors in the stomach may also be mistaken for it, but these are usually more superficial, more mobile, and often obey the respiratory movements of the diaphragm. The appearance of fatty matters in the stools is presumptive evidence of disease of the pancreas. Jaundice may be present in some cases of disease of the head of the pancreas from pressure on the bile-duct.

The Stomach

will be found usually to occupy the epigastric and part of the left hypochondriac regions, but its position is subject to great variation according to its state of distention and the condition of surrounding organs, its mobility allowing of much displacement. If the left lobe of the liver is enlarged, the stomach may be depressed into the umbilical region; and owing to ascites, abdominal tumors, etc., it may be pushed up so as to lie much under the cover of the ribs. In retraction of the left lung in phthisis, it may be dragged up into the left lateral region, and in extreme cases may be found high up in the axillary region.

The stomach may become enormously distended, This most frequently happens in stricture of the pylorus (simple or malignant). The distended organ may fill almost the whole abdomen, and even encroach to some extent on the chest, especially on the left side, but the distention is, as a rule, distinctly related to the epigastric region. The peristaltic action may occasionally be observed through the abdominal wall as a slow vermicular movement from left to right; it may sometimes be excited by friction in the epigastric region. The examination of the vomited matters often aids also in determining the existence of dilatation (see p. 404); the stomach tube may have to be used to ascertain the quantity and nature of the contents. The percussion note is highly tympanitic, and the organ can generally be pretty accurately mapped out, if the method of auscultatory percussion, already described (see p. 619), is employed. As there is usually fluid as well as air in the organ, change in position may alter the percussion limits. Thus, if the patient is laid on his left side, the fluid will gravitate into the "cul-de-sac." This fluid level should be carefully determined and marked, and the patient laid on his back or right side, when the previously dull area will become tympanitic, and the dulness will shift to the dependent portion. If the patient is placed on his hands and knees, the dulness will be transferred to the front, and the lateral regions will become clear. If the hands are placed on either side of the distended organ, and the patient shaken, the wave will be appreciated over an undue area and the fluid felt dashing from one side to the other, the splashing sound being often audible to the bystander; while, if auscultation is employed, Hippocratic succussion and its metallic phenomena are well heard. If the quantity of fluid in the stomach is considerable, and the fingers are depressed suddenly and sharply into the epigastric region, a sense of splashing on their passage into fluid is frequently apparent.

As distended stomach often depends on obstruction at the pylorus, palpation should be employed to find if any undue hardness, resistance, or tumor exists in that region. The pyloric orifice in such cases does not always maintain its normal position; it may be displaced to a great extent, but will generally be found somewhat to the right of the mesial line, and in the upper part of the abdomen. If cancerous disease of the pylorus exists, pain on palpation is usually complained of. The stricture may depend, however, on fibrous thickening or on cicatricial contraction resulting from old ulceration. Distention of the stomach may also be due to atony of the muscular coat.

The normal tympanitic note over the stomach may be replaced by dulness, quite absolute to superficial percussion, but on a stronger stroke being employed a trace of the tympanitic quality may still be found. Associated with this there is frequently distinct resistance and hardness on palpation, the pressure at the same time causing pain. These conditions are chiefly due to tumor of the body of the stomach, usually cancerous in its nature. Pain on pressure over the stomach, however limited in its area, and unassociated with dull percussion or increased resistance, is often due to simple gastric ulcer. The diagnosis must rest on the symptoms.

The Intestines

occupy the greater part of the abdomen. The small intestine lies in the lower and front part of the cavity. The transverse colon crosses the upper part of the umbilical region, and the ascending and descending colon occupy the posterior parts of the lumbar regions. The "caput cæcum coli" lies in the right, and the sigmoid flexure in the left, iliac regions, but the latter is usually overlapped to some extent by the small intestine. Over the intestine the note is tympanitic, but it varies in its quality according to the size and state of distention of the part. Normally the colon yields the deeper and fuller note. Areas of local dulness may present themselves at any part, depending on accumulation of feces or other substances in the intestines, tumors of the intestine, or of the glands, or of some of the other viscera in the abdomen; or the whole area of intestinal percussion may become more or less dull owing to morbid deposits in the peritoneum or omentum (tubercular or cancerous peritonitis), large tumors in the solid organs, effusion of fluid into the peritoneum, etc. On the other hand the intestines may become much inflated with gas, rendering the abdomen large, prominent, and to percussion very tympanitic, constituting what is known as "*tympanites*." This condition arises in many instances from obstruction in some part of the canal (intussusceptio, hernia, constriction from bands of lymph, twists in the gut, inflammation in its walls, accumulation of feces or foreign bodies, cicatrization of ulcers, strictures simple or cancerous, etc.). In many cases, however, tympanites is quite independent of obstruction, being found in acute peritonitis, in hysterical patients, in cases of dyspepsia where the digestive powers are feeble, in enteric fever, and in spinal lesions where there is atony of the muscular fibre of the tube. In certain very rare cases the tympanites may arise from the accumulation of gas in the peritoneal cavity.

In tympanites the abdomen is well projected in front, spherical, everywhere unduly resonant (unless the distention is very extreme, when it may become somewhat dull); the coils of intestine may sometimes be defined through the abdominal walls, and peristaltic action observed in them, if the walls of the abdomen are very thin, or if, from mechanical obstruction, there is hypertrophy of the muscular coat of the intestines. If the distention depends on obstruction the degree and distribution of the tympanites may to a certain extent guide the observer to the seat of lesion. If it is low down (in the rectum or sigmoid flexure) the distention will be found to occupy not only the anterior parts of the abdomen but also the flanks, the inflated colon bulging the lumbar regions. But the obstruction may exist at the ileo-cæcal valve, and in such cases the swelling will occupy chiefly the umbilical region and lower parts of the abdomen, there being no great distention in the lateral regions, and notably no bulging in the flanks.

Ascites

is often present in diseased conditions of the abdominal organs, more especially of the liver; but as this subject has been already discussed elsewhere, the student is referred for the details of the physical signs to Chapter XII., p. 435.

Ovarian Tumors and Cysts.

Cystic disease of the ovaries is very apt to be confounded with ascites, especially if the cyst is unilocular, or has one or two compartments developed out of all proportion to the others. In most cases the history is an important guide. The growth may have been first discovered as a small painless tumor in one or other iliac region, having gradually extended across the abdomen. The abdomen is well projected in front, and not bulged in the flanks as in ascites, and the umbilicus is rarely protruded. The percussion-dulness is in the anterior part of the abdomen, as the cyst expands up in front of the intestines and pushes them backward and upward. (Compare Fig. 71.)

Tympanitic percussion is thus got in the flanks, and alterations in the position of the patient do not change materially the relations of the dull and tympanitic areas. This is evidence that the fluid is not free. Fluctuation is common in ovarian cysts, but it may be vague, palpation giving merely the sense of elasticity, and in some cases solid matter can be detected at various parts of the tumor. On vaginal examination the uterus may be found normal in size, but high up in the pelvis, and perhaps displaced forward. In some cases the finger in the rectum can determine the relation of the tumor to the ovary, or its immediate vicinity; and examination with the uterine sound fails to show any direct connection with the womb. (Compare Chapter XII. and Chapter XV., pp. 437, 527.)

In many instances, however, ovarian cysts are accompanied by fluid effusion into the peritoneum, the result usually of the tumor or of rupture of the cyst; and the diagnosis may only be made clear by tapping, and examining the abdomen in its lax state; the character of the fluid removed may also guide us (p. 443).

Other Abdominal Tumors.

An ovarian cyst may be simulated by solid tumors of the ovaries or uterus, and even the gravid uterus has been mistaken for it. A careful examination by auscultation and otherwise will usually determine the diagnosis of pregnancy. (See p. 521.) *Solid uterine tumors* may be distinguished by their density, by their relations to the uterus, especially when examined by the uterine sound, by the elongation of its cavity, and an increase in its size and weight. There may be a feeling of movement or contraction on palpation, and a soft blowing sound may sometimes be heard on auscultation, synchronous with the patient's pulse. The tendency to metrorrhagia is likewise of great value in the diagnosis. (See pp. 513, 514, 523, 526, 527.)

A distended bladder might also be a source of confusion, but its growing out of the pelvis, fairly in the middle line, and being pyriform in shape, somewhat elastic, dull to percussion, and often tender on pressure, would probably raise such doubts as to lead to the introduction of a long flexible catheter, when the tumor will disappear.

Hydatid disease of the liver may enlarge so greatly as to fill the whole abdomen, but the history of growth from the right hypochondrium will often be quite clear, and the hydatid fremitus may be present. Hydatid disease of the peritoneum or omentum may present greater difficulty, and the diagnosis from ascites or ovarian cyst may only be arrived at by tapping and examination of the fluid; the presence of hydatids or hooklets determines the point at once. Even in the absence of these the characters of the fluid may give quite sufficient ground for the diagnosis. (See p. 443.)

Phantom tumor may present difficulties in diagnosis. It occurs almost exclusively in women, especially in those with hysterical tendencies, and it may simulate almost any form of abdominal enlargement; but the fact of its liability to vary in size and shape, the tension of the abdominal walls, and its disappearance under the influence of chloroform, will clear up the diagnosis.

Aneurism of the abdominal aorta is most common in the epigastric and umbilical regions, and may be recognized as a tumor placed in the length of the artery, lying in close apposition to the spine, but rather to the left side, and giving to the hand the sensation of expansile pulsation, in many cases associated with thrill. On auscultation a murmur may be heard coinciding with the expansion of the artery; in rare cases it may be double. Aneurism of any of the branches of the abdominal aorta may exist, especially in the cœliac axis or superior mesenteric artery. Pulsation of the abdominal aorta attended by murmur may be present without aneurismal conditions (see p. 341), but in such cases there is no impression of a distinct pulsating *tumor*, or of a murmur limited to the tumor as distinguished from one corresponding with the track of the aorta. Aneurisms may be simulated by tumors lying over the aorta, and having an impulse communicated to them. The diagnosis rests chiefly on the non-expansile character of the pulsation, but in many cases it is uncertain. Pain is often a marked feature in abdominal aneurism. It is usually felt in the back, is constant in character, as a rule, but subject to violent exacerbations, with extension of it down the limbs from implication of the sacral and lumbar plexuses. Obscure pain of this character, apart even from physical signs, should always raise the question of aneurism.

Localities of Tumors.

Leaving out of consideration the general enlargements of the abdomen due to ascites and tympanites, it may be well to indicate briefly a few facts with regard to local enlargements or tumors. A tumor being discovered in the abdomen, the whole physical inquiry hinges on the question, What organ or structure is it connected with? In such an inquiry it is of prime importance to consider the regional divisions of the abdomen mentioned in the early part of this section, and the organs contained in them. If the tumor is confined entirely or chiefly to one of these regions, then the various organs must be gone over in detail to see from which it springs. In serious diseases, however, the abdominal organs may be greatly displaced from their ordinary position. It will suffice for our purpose to indicate what tumors are most frequent in the varicose regions.

In the *epigastric region* the tumors most frequently met with are cancerous growths in the pylorus or body of the stomach, enlargements of the left lobe of the liver, tumors of the pancreas, and aneurisms of the aorta. It is to be remembered that the left lobe of the liver may present itself as a tumor without there being any enlargement of it, conditions in the thoracic viscera having depressed the organ. The same remark applies to the liver in the right hypochondrium and to the spleen in the left.

The tumors met with in the *umbilical region* are aneurisms of the aorta, or some of its branches, omental tumors, fecal accumulations in the transverse colon, floating kidney, and at times cancer of the intestine and enlarged mesenteric glands. Fecal accumulations may occur even with a history of diarrhœa: through the abdominal wall they can be moulded to some extent by steady pressure with the fingers, and may even be displaced a little along the bowel.

Tumors originating in the *hypogastric region* are distended bladder, the gravid uterus, tumors of the womb and its appendages, and inflammatory swellings in the pelvis.

Those originating in the *right hypochondrium* are chiefly from the right lobe of the liver or gall-bladder.

In the *left hypochondrium*, the spleen is the organ chiefly affected, although fecal accumulations in the splenic flexure of the colon may occur.

In the *lumbar regions*, tumors of the kidneys, perinephritic abscess, lumbar abscess, and fecal accumulations are most frequent.

In the *iliac regions*, ovarian cyst, pelvic abscess, disease of the cæcum or sigmoid flexure, enlarged glands, pelvic cellulitis or hematocele are found; tumors connected with bones may also appear in this situation.

It is rare, however, for tumors to occupy only the region from which they spring. They often involve several regions; and it is only by a careful consideration of the history and symptoms, along with the physical signs, that a diagnosis can be arrived at. In not a few instances several organs may be affected, and this renders the examination all the more perplexing. In many cases the most critical exploration may fail to resolve the doubts.

Percussion was employed more or less in abdominal cases from early times, but its first application to the chest was by Auenbrugger, Inventum novum ex percussione thoracis humani ut signo abstrusos interni pectoris morbos detegendi, Vindobonae, 1761. Little attention was given to the method till Corvisart published his translation of this work (1808), and Piorry took up the subject in a series of publications (De la percussion médiate, Paris, 1828); his latest and most important is Traité de plessimétrisme et d'organographisme, Paris, 1866.

Auscultation as applied to the diagnosis of diseases of the heart and lungs was unfolded in a great work by Laennec, Traité de l'auscultation médiate, Paris, 1819; a translation by Sir John Forbes was published, 3d edition, London, 1829.

Another work on these subjects of historical importance was first published in Vienna, 1839, viz., Skoda, Treatise on Auscultation and Percussion; translated by W. O. Markham, London, 1853.

Physical Diagnosis.—The following also deserve special attention: Gee, Auscultation and Percussion, 3d edition, London, 1883.—Guttmann, Hand-book of Physical Diagnosis, translated by Dr. Alex. Napier for New Sydenham Society, London, 1879.—Flint (Austin), Manual of Percussion and Auscultation, 3d edition, Philadelphia, 1883.—Loomis, Lessons in Physical Diagnosis, 3d edition, New York, 1872.—Weil, Handbuch und Atlas der topographischen Percussion, 2e Aufl., Leipzig, 1880.—Gerhardt, Lehrbuch der Auscultation und Percussion, 3e Aufl., Tübingen, 1876.—Niemeyer (Paul), Grundriss der Percussion und Auscultation, 2e Aufl., Erlangen, 1873.—Woillez, Traité théorique et pratique de percussion et d'auscultation, Paris, 1879.—Eichhorst, Lehrbuch der physikalischen Untersuchungsmethoden innerer Krankheiten, Braunschweig, 1881. More general works on Diagnosis also deal with this subject—*e. g.*, Da Costa, Medical Diagnosis, 6th edition, Philadelphia, 1884.—Graham Brown, Medical Diagnosis, 2d edition, Edinburgh, 1883.—In addition to these, all works on the practice of medicine will be found to give information as to special diseases.

Lungs, in addition to the above.—Walshe, Practical Treatise on Diseases of the Lungs, 4th edition, London, 1871.—Stokes (William), Treatise on the Diagnosis and Treatment of Diseases of the Chest, Part I., Diseases of the Lung and Windpipe, reissued by New Sydenham Society, London, 1882.—Waters, On Diseases of the Chest, 2d edition, London, 1873.—Powell (R. Douglas), On Diseases of the Lungs and Pleura, including Consumption, 3d edition, London, 1886.

Heart.—Walshe, Practical Treatise on the Diseases of the Heart and Great Vessels, 4th edition, London, 1873.—Balfour (Geo.), Clinical Lectures on Diseases of the Heart and Aorta, 2d edition, London, 1882.—Bramwell (Byrom), Diseases of the Heart and Thoracic Aorta, Edinburgh, 1884.—Hayden, Diseases of the Heart and Aorta, Dublin, 1875: this elaborate book may be consulted for special details.—Samsom, Lectures on the Physical Diagnosis of Diseases of the Heart, London, 1876: this book contains in small compass all that is most important.—Von Dusch, Lehrbuch der Herzkrankheiten, Leipzig, 1868.—Friedreich, Krankheiten des Herzens, 2e Aufl., Erlangen, 1867.—Peter, Traité clinique et pratique des maladies du cœur, Paris, 1883.—The works of Hope, Stokes, and Latham, have a permanent importance in the history of this subject, although in a sense superseded.—The papers of Dr. Gairdner, which have been freely used in this chapter, will be found in his Clinical Medicine, Edinburgh, 1862, and the Glasgow Medical Journal for 1867.

Sphygmograph and Cardiograph.—Marey, La circulation du sang, Paris, 1881: and his earlier work, Physiologie médicale de la circulation du sang, Paris, 1881.—Lorain, Le Pouls, Paris, 1877.—Ozanam, La circulation et le pouls, Paris, 1886.—Dudgeon, The Sphygmograph, London, 1882.—Bramwell (Byrom), The Students' Guide to the Examination of the Pulse and the Use of the Sphygmograph, 2d edition, Edinburgh, 1883 —Mahomed, Medical Times and Gazette, 1872.—Galabin, Medico-Chirurgical Transactions, vol. lviii., London, 1875: and Guy's Hospital Reports for 1875.—Works on Physiology may also be consulted with advantage, especially those of Dr. Michael Foster, 4th edition, London, 1883; and of Landois, translated by Dr. Stirling, London, 1885.

Abdomen.—Bibliographical references are given at the end of Chapter XI. on "Disorders of the Digestive System;" of Chapter XII. on "Jaundice and Dropsy;" of Chapter XIII. on the "Urine and Urinary Symptoms;" and of Chapter XV. on "Disorders of the Female Organs." These will be found to comprise most of the subjects dealt with in this section. Of course, the works enumerated above on physical diagnosis should also be consulted.

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